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Educators' Perspectives of Science Instruction in Title I Elementary Schools to Improve Achievement

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
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Walden University
2024

Abstract

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MA, Troy University, 2009

BS, Albany State University, 2006

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

Teacher Leadership

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Abstract

The problem addressed in this study was that students in upper elementary at four Title I elementary schools did not meet district achievement standards in science for four consecutive years, which could impede their educational and employment futures. Little is known how teachers in these elementary grades taught science content to improve student achievement. The purpose of this basic qualitative study was to explore five upper elementary educators' perspectives of science instruction to improve achievement in Title I elementary schools in a southeastern state. The conceptual framework that grounded this study was a three-dimension concept of science, including scientific and engineering practices, cross-cutting concepts, and disciplinary core ideas. A purposeful sample of one administrator and four elementary teachers, with at least three years in their current positions, participated in semistructured interviews. Interview data were analyzed inductively and coded for themes. Participants revealed that they used contracted resources, collaborative planning, and a variety of teaching methods, instructional materials, and technology tools during instruction to improve student achievement in science, and they incorporated several assessment methods to monitor student progress toward achievement of science standards. A white paper was created based on the study's findings, resulting in three recommendations for elementary educators. Positive social change is possible if science teachers use content area reading strategies and STEM learning and are trained to use literacy assessment knowledge to improve student academic performance, thus, leading to potential postsecondary education and careers in science.

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Dedication

This was a very long process, but with many tears and feelings of defeat, I persevered to the finish line. I would not have been able to finish this without God and support from my family.

To my dad, Marshall, I DID IT!

To my mother, Arlene, and my godmother, Barbara thank you ladies so very much for everything. You kept me lifted up in prayer and did not allow me to give up. Thank you for seeing me to the finish line. I am forever grateful for your words of wisdom, words of comfort, and words of affirmation. I love and appreciate you to infinity and beyond.

Omariah, Meleah, and Marlee, my girls. You all are the three reasons I was determined to finish what I started. I am so proud of you girls and I hope this process has shown you all to go after what you want and never give up. Thank you for bearing with me and sacrificing with me. Mommy loves you.

To my siblings, Antwan and Janae. I appreciate and love y'all. Thank you for everything. I truly could not have finished this without you.

And lastly, to my accountability partners, Dr. Tonya and Dr. Dee, THANK YOU for checking on me, and making sure I saw this thing through to the end. You ladies rock!

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Dr. Howe, you came in and saved the day. During our first conversation, you told me that we would finish this and we did it. I am so glad I finished this journey under your guidance. Thank you doesn't seem adequate to show my appreciation for you. Dr. Frese, thank you for sticking with me and encouraging me. There were many times during the past few months when I sat at my computer and felt like I wouldn't make it through the revisions, but I did and I appreciate you!

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Table of Contents

Section 1: The Problem

The Local Problem

According to the National Science Board (2013), the future success of the U.S. economy, environment, and safety depends on scientific and technological innovations in health, industry, military, and energy. This requires an increase the number of graduates who are equipped with skills in science, technology, engineering, and mathematics (STEM; National Science Board, 2013; U.S. Department of Education, n.d.). However, the Nation's Report Card for 2015 showed that the nation's children enrolled in public schools achieved low scores in science. Based on scores for fourth, eighth, and 12^{th} grade, more than 50% of students scored basic or below basic in 2015, and scores decreased as students advanced through the grades. The subgroup of students who achieved the lowest science scores in 2015 were students from low-income families as indicated by their participation in the National School Lunch Program. In fourth grade, more than 70% of these students achieved basic or below basic, in eighth grade, more than 80% achieved basic or below basic, and in 12^{th} grade, more than 90% scored basic or below basic (National Center for Educational Statistics, 2017).

In one of the largest school districts in southeast South Carolina, fewer than 50% of students in Grades 3, 4, and 5 at four Title I elementary schools did not meet achievement standards in science as measured by the South Carolina Palmetto of State Standards (SCPASS) during 2013 through 2017, and at four other Title I schools, more than 60% of students did meet the standards. According to an internal report from the organization under study, the district employs 3,384 teachers who serve a student population comprised of predominately White (47%) and African American (39%) with a small Hispanic (9.4%) and Asian (1.6%) population. (National Center for Education Statistics, 2015). There are 139 rural, urban, or suburban schools in the district, of which 49 are elementary schools (National Center for Education Statistics, 2016). Thirty of the elementary schools, or 61%, are designated Title I schools (United States Department of Education, 2018). Of the total student population of 49,837, 53% are classified as low-socioeconomic status and qualify to participate in the free and reduced meals program (South Carolina Department of Education, 2018). It is unknown what educators did to address mixed results on state assessments in the target Title I schools.

It is important to conduct research that attempts to achieve more understanding of the problem that may lead to efforts to improve science education in the United States. The National Academy of Sciences, National Academy of Engineering and Institute of Medicine (2010, 2011) have argued that as adults, children with low levels of science learning will lack scientific literacy and reasoning rendering them unable to understand public science policies or be employed in the 21st century economy, which is focused on science, engineering and technology. The gap in practice that the study addressed is unknown what experiences educators did to improve students' science achievement. I explored five upper elementary educators' experiences teaching science to improve achievement in Title I elementary schools in a southeastern state. This exploration featured a basic qualitative design using semistructured interviews.

Rationale

Between 2013-2017, approximately 48% of students at the Title I elementary schools in the study district had achieved *met* and *exemplary* on the state mandated South Carolina Palmetto Assessment of State Standards (SCPASS). An assistant principal at one of the study schools stated,

> When looking at the science data, either we are not teaching science as required, or our students just aren't doing well on the test because they are not good test takers. As a district, we do poorly because science is more inquiry based and hands-on and we don't do that … as a district very well

The data gathered for the Title I schools from the SCPASS are evidence that science achievement is an area of difficulty for some Title I elementary schools. The overall lack of adequate progress on the SCPASS in this school district for some Title I elementary schools is and should be a concern for the schools, administrators, and the community. The purpose of this study was to explore five upper elementary educators' experiences teaching science in Title I elementary schools in a Southern state.

Evidence of the Problem from the Professional Literature

The National Assessment of Educational Progress conducts a national assessment of student achievement in the United States for Grades 4, 8, and 12. In the United States in 2015, 24% of fourth-grade students scored below basic, 38% scored basic, 37% scored proficient, and only 1% scored advanced. In eighth grade 33% of students scored below basic, 34% scored basic, 31% scored proficient, and 2% scored advanced. In 12th grade, 41% of students scored below basic, 38% scored basic, 19% scored proficient, and 2% scored advanced. In all three grade levels, more than 50% of students scored basic or below basic in 2015 (National Center for Education Statistics, 2015). Further, the results of the 2015 Programme for International Student Assessment, showed that United States ranked 25th in the world in student science proficiency (Center of Educational Policy, 2015).

In the United States, schools place more emphasis on reading and mathematics than on science because schools are held accountable for student achievement in mathematics and reading and are not held accountable for student science achievement even though science achievement is evaluated (Judson, 2013). As a result, teachers tend to spend less classroom instructional time on science (Judson, 2013). Blank (2013) Previous research revealed that elementary teachers in Grades 1-4 spent an average of approximately 2.5 hours per week teaching science in comparison to 11 hours per week in English/language arts instruction and 5.6 hours a week in mathematics (Blank, 2013). The time devoted to science classroom instruction has been on a steady decline since 1988 (Blank, 2013). The National Assessment of Educational Progress results show that more time on science instruction means higher National Assessment of Educational Progress scores for students regardless of socioeconomic status. There was a 12-point difference between students who received less than 1 hour of science instruction per week and those who received more than 4 hours of science instruction per week. An increase in instructional time provides students with an opportunity for increased student achievement (Blank, 2013; Judson, 2013). Thus, the purpose of this study was to explore five upper elementary educators’ experiences teaching science to improve achievement in Title I elementary schools in a southeastern state. This study featured elements from the literature about current practices in science instruction and instructional time.

Definition of Terms

Title I school: Title I schools enroll a student population that consists of at least 40% of children from low-income families as identified by the National School Lunch Program eligibility data receive federal funding. The funded services must focus on students who are at risk of failing or are already failing to meet state standards to ensure that they meet challenging academic content and achievement standards (U.S. Department of Education, 2015).

Significance of the Study

Teachers may benefit from this study by understanding what worked and how challenges were overcome during science instruction. Ultimately, their instruction could support student academic achievement in elementary science. This understanding could be key to transforming the learning experience for students and teachers.

Students may benefit from the study by receiving more effective science instruction. The study district may increase science instructional time, and hands-on and inquiry-based science activities, which may result in students developing interest in science career fields. This project study may contribute to social change at the district level by increasing the percentage of students meeting state standards on the science SCPASS.

Research Question

What are five upper elementary educators' perspectives of science instruction to improve achievement in Title I elementary schools in a southeastern state?

Review of the Literature

The purpose of this study was to explore five upper elementary educators' experiences teaching science to improve achievement in Title I elementary schools in a southeastern state. It is unknown what educators did to address mixed results on state assessments in the target Title I schools. Best practices for science instruction based on current research will guide the exploration of this research phenomenon. To provide a context for the study, I explored the following topics in my literature review: (a) teacher preparation programs in science education, (b) teacher professional development in science education, (c) research related to elementary science instructional practices, and (d) factors that affect science achievement at the elementary level.

Relevant literature for this study was gathered from the following databases in Walden's online library: Education Source, the Education Resource Information Center (ERIC), SAGE, Teacher Reference Center, Academic Research Complete, and Research Starters-Education. I also searched Google Scholar. I used the following search terms to locate peer-reviewed journal articles, reports, and dissertations published within the last five years: *teacher preparation for science teaching, elementary science education, elementary science teacher preparation, elementary science in-service, science professional development for teachers, elementary science best practices, science teaching practices, science standards, elementary science education, elementary school science, elementary science, factors that affect elementary science, factors elementary science,* and *science.* The research was concluded when the search terms yielded no new articles, reports, or dissertations.

Conceptual Framework

The conceptual framework that grounded this study was a three-dimension concept of science, including scientific and engineering practices, cross-cutting concepts, and disciplinary core ideas for K-12 education (Pratt, 2013). The framework's overarching goal is for 12th grade students to leave public school with an understanding of science as an art form, verbal skills to engage in conversations about science and engineering issues, skills to apply scientific and technological information in their daily lives, as lifelong learners about science, and have the skills to qualify for careers in science, engineering, and technology. To achieve this goal, the three dimensions are viewed as integrated parts, rather than separate entities in the curriculum and instruction in K-12 settings.

The first of the three dimensions is scientific and engineering practices (Pratt, 2013). This dimension is a revision of the way science was previously taught. The notion is to present scientific inquiry as a multifaceted experience, involving questioning, defining, developing and using exhibits, preparing and completing inquiries, evaluating and explaining data, reporting explanations and recommendations, and communicating information (Pratt, 2013). For the K-12 teachers, instruction is not in an isolated set of elements, but is part of integrated instruction.

The second dimension are seven crosscutting concepts: patterns, cause and effect—mechanism and explanation; scale, proportion, and quantity; systems and system models; energy and matter—flows, cycles, and conservation; structure and function; and stability and change (Pratt, 2013). These concepts are essential to understanding science and engineering. Again, these concepts are not considered in isolation but as the whole within each science discipline.

The last dimension, disciplinary core ideas, cover the physical, life, earth and space, and engineering, and technology disciplines, and applications of sciences (Pratt, 2013). Within each core are five-13 component ideas that are useful in describing the explicit understandings of each of the sciences. Teachers are expected to use the ideas to develop questions, describe the interplay among the ideas for the core idea, connect multiple sciences, adjust science curricula, and advance opportunities for further training in science instruction. To meet these expectations, teachers are encouraged to engage in a variety of professional development opportunities and a search for resources to integrate these three dimensions.

Teacher Preparation for Teaching Science at the Elementary Level

The research literature showed that elementary teachers are underprepared for teaching science (Lewis et al., 2014). Part of this insufficient science preparation may be due to the generalist training who elementary teachers often receive. Of the over 1.5 million elementary teachers in the United States, most are generalists who teach multiple subjects (social studies, mathematics, language arts, science, and health; Olson et al., 2015). Typically, preservice preparation for elementary level teachers includes courses in each of these curriculum content areas. In many cases, elementary preservice teachers are better prepared to teach reading and mathematics than science (Olson et al., 2015). Individual states also determine the requirements for elementary teacher preparation programs, and many teacher education programs require only one science methods course

(Bergman & Morphew, 2015; Kirst & Flood, 2017; Olson et al., 2015; Miller et al., 2013; Santau et al., 2014; Steinberg et al., 2015). However, one course cannot cover the knowledge and skills needed to create and examine scientific explanations and evidence, understand scientific explanations of natural phenomena, take part in scientific practices, and understand the development and nature of scientific knowledge (National Research Council, 2007). Moreover, the structure of undergraduate science courses does not lend itself to elementary teacher preparation (Steinberg et al., 2015). In particular, the lecture-based format of these courses conflicts with the hands-on approach that teachers are expected to use at the elementary level. As a result, many preservice teachers do not graduate with the knowledge and experience needed to teach elementary science effectively (Steinberg et al., 2015).

The National Research Council recommended that preservice teachers receive science preparation through a program that enables them to learn scientific theories with true understanding, experience scientific inquiry, and reflect on their learning. Since scientists learn best by participating in hands-on science activities such as conducting experiments, future science teachers should be taught to ask questions, make observations, reason scientifically, problem solve, and develop scientific models. These critical science skills should be modeled for preservice teachers to adequately prepare them to implement hands-on learning in their own elementary classrooms (Bergman & Morphew, 2015; Miller et al., 2013; Olson et al., 2015; Santau et al., 2014; Steinberg et al., 2015).

Science Content in Teacher Education

Science teacher preparation programs should focus on developing teachers understanding of elementary science curriculum content and on the scientific process (Steinberg et al., 2015). For example, when preservice teachers took a course that covered principles of physical science, life science, or environmental science, they received higher grades in their Science in Elementary Education course, and they felt more comfortable, confident, and prepared to teach elementary science (Steinberg et al., 2015). In a national survey of 881 elementary science and mathematics teachers, only 40% of the participants felt well-prepared to teach science, while 6% of the science teachers reported that they had not taken any college science courses (Trygstad, 2013). Recommendations from within the field reassert the importance of more in-depth science training for educators at the elementary level (National Science Teaching Association, 2012). Elementary science teachers need be prepared to teach content standards and implement scientific investigations that will increase students' conceptual understanding, which requires a deeper knowledge base in science methods (Olson et al., 2015). For example, in a course to help participants learn the 5E Instructional Model as a theoretical framework—(a) engage, (b) explore, (c) explain, (d) elaborate, and (e) evaluate—teachers learned to prepare science units and lessons that engage students and offer students opportunities to explore, explain, and elaborate on the concepts (Santau et al., 2014). Results showed a significant improvement in the participants' understanding and development of science content knowledge because of the course (Santau et al., 2014).

Pedagogy in Teacher Education

A growing body of evidence has begun to shed light on the teaching strategies that may be more effective as part of a teacher preparation science program to equip instructors with the knowledge and skills needed to support student science learning in the classroom (Bergman & Morphew, 2015; Miller et al., 2013; Olson et al., 2015; Santau et al., 2014; Steinberg et al., 2015). For instance, recognizing the need for more in-depth elementary science teacher preparation, Miller et al. (2013) developed the following components for Model of Research-Based education (MORE) for Teachers: coherent design and content preparation; science courses that model exemplary science instruction; field experiences that involve observing teachers; and an additional mentoring component in the areas of instructional planning, providing students with feedback after instruction, and questioning strategies. The program founders advised teaching preservice elementary science teachers how to listen to students' ideas about science, investigate meaningful questions, use evidence to support their claims, and connect new ideas to previous learning. Moreover, they recommended that preservice teacher be provided with opportunities to gain both knowledge about and experience in allowing students to share what they know about a scientific standard or topic of study, and guiding students to use that knowledge to build on what they are learning. The MORE for Teachers program may serve as a useful model for the development of other science teacher preparation initiatives; however, gaining more insight into exactly what current science teachers find lacking in their preparation would help refine such preparation even further.

Another argument in the literature is that existing teacher preparation programs tend to focus more on the pedagogy of science rather than on the actual content (Santau et al., 2014). Otto and Everett's (2012) study is an example of an attempt to change this practice in current teacher preparation. The researchers used a science capstone course to introduce preservice elementary teachers to pedagogical content knowledge (PCK), teaching them how to connect the overlapping knowledge of three instructional components within the science classroom: (a) student's prior knowledge (context), (b) subject matter content, and (c) pedagogy. For example, Otto and Everett modeled for the preservice teachers how to teach the eight phases of the moon, the causes of the moon phases, and the relationship of the sun and the earth to the moon using a variety of teaching strategies such as hands-on activities, videos, visual aids, and models. Utilizing a three-circle Venn diagram that showed the relationship of content, context, and pedagogy, the teachers created and taught two lessons. Through a pretest-posttest design, the researchers found that teachers who participated in the course were instructed in the Venn diagram method were better able to develop science lesson plans that effectively connected the three components of content, context, and pedagogy. The challenge with such instruction remains how to ensure that teachers understand the content, as well as the pedagogy, and develop a positive association with the subject matter.

In another study addressing pedagogical strategies to prepare preservice science teachers more effectively, Bulunuz and Jarrett (2010) conducted mixed methods research involving pretest and posttest assessments exploring the impact that participating in hands-on learning stations would have on preservice teachers' understanding of earth and space science. The participants were second-year graduate students and elementary school teachers enrolled in a science methods course specifically designed to prepare instructors for teaching in high-poverty elementary schools. The posttest revealed that many participants with an initially low conceptual understanding of the science concepts demonstrated improved comprehension of those concepts after participating in hands-on activities. This suggests that a hands-on learning approach that introduces teachers to specific concepts may prove effective in better preparing them for teaching science education. In summary, the existing literature on effective science teacher preparation, while limited, indicates that programs should provide instruction focused more on subject matter content than on pedagogy (Santau et al., 2014) and employ teaching strategies that allow for hands-on learning (Bulunuz & Jarrett, 2010) and the use of dynamic learning tools like Venn diagrams and graphic organizers (Otto & Everett, 2012).

In-Service Preparation for Teaching Science

For a new teacher at the beginning of their career, professional development, also called in-service training, can help refine and expand one's knowledge of science and effective teaching methods for science instruction. Such professional development should equip teachers with tools needed to address challenges that arise during science instruction and be aligned with teachers' actual needs (Zhang et al., 2015).

A 3-year study of professional development for K-12 science teachers was designed to determine what instructors needed to learn and what actions they needed to take to be effective teachers of science (Zhang et al., 2015). Participants chose two science units in which they felt they needed further training and identified specific areas for improvement within those two units, presenting their reasoning for choosing each unit and describing what they would most like to improve. The study also sought to identify the specific needs of the participants to improve the selected science units and explored how teacher needs varied depending on demographic variables including their experience, instructional grade-level, and gender. Participants ultimately selected 230 science topics for improvement. The greatest need for improvement by grade level was at the elementary level where teachers needed to improve their understanding of content, develop effective assessment, and find additional materials to improve instruction. The researchers specifically acknowledged that prior professional development research lacked an understanding of the specific areas for improvement among the teacher population (Zhang et al., 2015). These findings may help to inform the development of more effective science teacher professional development initiatives; the current study aims to further this knowledge specifically at the elementary level.

High-Performing Schools in Other Countries

Research examining high-performing science programs within schools in other countries may also be insightful to the improvement of science teacher instruction within the U.S. The ability to improve students' science learning rests specifically on the preparation of and support provided to teachers (National Research Council, 2012). Jensen et al. (2016) identified three essential components for adequate science teacher preparation through a study of elementary teacher training programs at high-performing school districts in Japan, Finland, Shanghai, and Hong Kong. These components included teachers' knowledge of basic science concepts, teachers' abilities to conduct classroom discussions that reveal student thinking about science, and teachers' reflections on their teaching and students' learning. Hoisington and Winokur (2018) applied Jensen et al.'s (2016) three components during a 4-day professional development for kindergarten teachers in the U.S. The kindergarten teachers explored science phenomena by engaging in "active, minds-on, adult investigations" (p.74). The instructors modeled how to circulate among the group, ask questions that connect to the concepts, and facilitate science discussion that makes connections between their observation and the concepts being taught (Hoisington & Winokur, 2018). The researchers concluded that to become knowledgeable about basic science concepts, "teachers need a thorough understanding of basic concepts" (p.74). Moreover, they found that teachers should be cognizant of students' level of understanding about those concepts.

Direct Experiences

Teachers often use single activities to teach science information and facts, and science vocabulary is frequently taught solely from books or other static sources (Hayes & Trexler, 2016; Hoisington & Winokur, 2018). However, learning science concepts and vocabulary requires more than direct teaching. For students to learn science concepts and vocabulary, students need to have several direct experiences as well as opportunities to experiment (Hayes & Trexler, 2016; Hoisington & Winokur, 2018). When teachers learn about how students think about science, teachers can better facilitate science inquiry. When teachers allow students to share their thinking, students have more of an opportunity to develop literacy and language skills (Hoisington & Winokur, 2018). According to Hoisington and Winokur, reflection creates a culture that builds "trust, confidence, and collaboration" (p.78). Reflecting on teaching and learning is an interactive process. When teachers reflect on their teaching and their students' learning, they gain a better understanding of science concepts and how children learn those concepts and can make changes that drive instruction.

The Induction Phase and the Role of Mentors

During their first 3 years in the profession, teachers are transitioning from learning *about* teaching to learning *while* teaching, commonly referred to as the induction phase (McNally, 2015). Teachers benefit from professional development during the induction phase that supports them as they learn about teaching. Research has suggested that mentor teachers should provide preservice teachers with pedagogical knowledge, consulting and coaching strategies, and the components of effective science instruction that will support science learning in the elementary classroom (McNally, 2015; Miller et al., 2013). McNally (2015) conducted a qualitative study where eight induction science teachers participated in an online mentoring program, e-Mentoring for Student Success (eMSS). eMSS is a program that offers mentor and mentee professional development support activities including structured and unstructured discussions, classroom scenarios, as well as science content and pedagogy and classroom observation and feedback.

The researcher found that classroom observation cycles can be used to support professional development by providing induction teachers with opportunities to learn from their own classroom teaching (McNally, 2015). Moreover, McNally recommended that mentees should be paired with mentors who understand and appreciation what they teach; observations should focus on how teacher actions impact student learning opportunities in elementary science; mentees should self-assess and use classroom teaching as a tool to learn to teach elementary science; and mentors and mentees should work together to develop an action plan of alternative teaching approaches and participate in continued professional development opportunities for elementary science teaching (McNally, 2015).

School and Student-Based Factors That Affect Elementary Science Achievement

Researchers have investigated various school and student-based factors that may affect elementary students' science achievement. Bursal et al. (2015) conducted a study about the decrease in science achievement of elementary students in Grades 4-8. The findings were consistent with national achievement test results indicating a decrease in elementary students' science scores as their grade level increased. Study participants had less than a 50% success rate on science tests. According to Bursal et al. (2015), the decrease in science achievement could have been associated with several factors, such as the increasingly abstract nature of science concepts as the grade level increases (e.g., atom structure, cell division) and the insufficient preparation of teachers to teach elementary science. Science achievement at higher grade levels may also depend on students' early exposure to high-quality science curriculum and learning (Bursal et al., 2015). Various school and student-related factors influencing achievement are discussed in the following sections.

School-Based Factors

The list of factors related to the school environment that may affect performance outcomes is extensive and may differ depending on grade level. School-based factors that researchers have found to affect student science achievement at the elementary level include the following: minutes of weekly science instruction, teacher experience, amount of science inquiry in the classroom, and access to resources (Blank, 2013; Johnson & Hull, 2014; Kaya & Rice, 2010; Nowicki et al., 2013; Romance & Vitale, 2012).

Nowicki et al. (2013) conducted a mixed methods study to determine what factors (grade level, science topic, use of classroom science kits, teacher years of teaching experience, college-level science preparation, and level of comfort with teaching science concepts) were associated with the accuracy of elementary science content. The science content was delivered in elementary science classrooms by teachers, most of whom used classroom science kits like Full Option Science Systems (FOSS). Science kits made a significant difference in the accuracy of the lessons, with an average accuracy rate of 90% as measured by a science content test, compared to 79% for nonkit-based lessons. Nowicki et al. (2013) also found that teachers in Grades 4 and 5 presented a higher level of content accuracy than teachers in Grades 1-3, which may be related to the strong focus on reading and math skills in the lower grades. Finally, the study found that over 50% of the teachers identified a high preference for teaching science, which was a significant predictor of higher rates of content accuracy (Nowicki et al., 2013).

Student-Based Factors

Student-based factors that affect student science achievement at the elementary level are closely linked to the socioeconomic status of students and their families, home resources, and student’s science self-confidence (Blank, 2013; Kaya & Rice, 2010; Morgan et al., 2016). Kaya & Rice (2010) focused on the effects of student and classroom factors on elementary science achievement by analyzing data from fourth grade students and their teachers who participated in the Trends in International Mathematics and Science Study. They found that home resources and science self-confidence were two main factors that affected elementary science student achievement. Availability of educational resources at home, like books, a computer, and a study desk, strongly predicted science achievement (Kaya & Rice, 2010).

A subsequent study by Morgan et al. (2016) analyzed a data set of Early Childhood Longitudinal Study (ECLS-K) scores of children from kindergarten through eighth grade on a general knowledge test, and science achievement scores for students in Grades 3-5. They specifically investigated the rate of achievement growth as students matriculated through elementary and middle school and the variation of achievement gap by race, ethnicity, and family socioeconomic status. The science achievement gaps reported were strongly attributed to students' general knowledge gaps at the kindergarten level, indicating that gaps in scientific knowledge begin early for students (Morgan et al., 2016). This finding highlights the critical importance of accurate and thorough science instruction at the early elementary school level.

Best Practices for Elementary-Level Science Instruction

Literature on elementary-level science instruction has documented various best practices, while also investigating the impact of external factors on science teaching, including state assessments and the No Child Left Behind Act. First, I will discuss the impact state assessments have on science instruction. Then, I will explore inquiry-based science instruction. Following that, I will discuss instructional strategies and core teaching practices for the elementary science classroom.

State Assessments

Effective science instruction and instructional practices became increasingly important as states were required to measure student achievement toward the mastery of science standards using state assessments. According to federal regulations, states must assess students in science once at the elementary level in Grades 3, 4, or 5; once at the middle school level in Grades 6, 7, or 8; and once in high school in Grades 10, 11, or 12 (United States Department of Education, 2007). Hayes and Trexler (2016) have asserted that the focus on math and reading/language arts to prepare students for state assessments has affected science education by leaving less time for science instruction involving hands-on or inquiry-based pedagogies.

Teachers have serious concerns regarding the impact of testing on science instruction. In a qualitative study, Milner et al. (2012) explored teachers' beliefs about their elementary science teaching and classroom practices, including challenges they faced before and after the state science testing became a federal mandate as part of the No Child Left Behind Act. Participants shared concerns about the preparation time required for science instruction and the inadequate access to subject-specific materials and supplies. Several teachers felt that pressures from the state to teach reading and mathematics discourages them from teaching science and resulted in decreased science instruction time. While instructors understood the importance of making science relevant to students, they were faced with a lack of time, resources, materials, and professional development to facilitate such instruction. Thirty-six percent of the teachers had to link science instruction to their reading, writing, literacy, or spelling lessons to satisfy the science requirement (Milner et al., 2012).

The concerns voiced by Hayes and Trexler (2016) and Milner et al. (2012) point to the need for science learning to be made a priority locally and statewide at all grade levels in order to ensure that achievement in science does not decrease as students transition from elementary to middle and high school. When students lack meaningful science instruction at the elementary level, the chances of them performing well in middle or high-school science decrease since they have not mastered the basic skills needed to grasp the more advanced science concepts covered in higher grades (Milner et al., 2012). Without some level of accountability for science achievement at the elementary level, science instruction will continue to be minimized, presenting a clear barrier to the national goal of improving science education (Milner et al., 2012).

Inquiry-Based Science Instruction

In 2000, the National Research Council released the National Science Education Standards outlining what students need to know and understand to be scientifically literate. These standards were intended to shift the focus of science teaching from traditional teacher-led instruction to more student-centered instruction (National Research Council, 2000) with recommendations focusing on inquiry-based science instruction to develop critical thinking in science. Schwartz et al. (2004) defined inquiry-based science as the processes used to gather scientific knowledge, which require students to make observations, ask questions, design and conduct investigations to answer questions, use scientific tools to analyze and interpret data, and employ logical and critical thinking skills to form explanations using evidence.

In Tan and Wong's (2012) case study of a sixth-grade classroom where the teacher used inquiry-based instruction as the preferred teaching methodology, the researchers examined the effects of using a hands-on approach to teach the conversion of energy. The teacher first led students through questions to review knowledge about the concept, then introduced the activity and engaged the students by showing them a model toy, then gave them procedural instructions for the experiment and had students make predictions and document their hypotheses. After the experiment was complete students shared their data and findings in a whole-group discussion. The researchers found that this inquiry-based approach resulted in more diverse and dynamic types of interactions and learning by the students. Tan and Wong (2012) recommended that teachers be introduced to science inquiry to help them reflect on their teaching practices and transition from traditional modes of instruction to more inquiry-based instruction. Finally, they noted that they science activities that teachers choose should be aligned with the teaching outcomes they hope to achieve.

Instructional Strategies

Adamson et al, (2013) conducted a study in a large urban elementary school district to examine the instructional strategies that elementary teachers used to foster scientific inquiry and understanding in their classrooms during science instruction. Adamson et al. (2013) identified several instructional strategies such as a) helping students connect learning to real-world experiences and prior knowledge, b) developing and implementing hands-on activities, and c) identifying and addressing the difficulties that students experienced during classroom instruction. Adamson et al. (2013) identified two strategies that were less commonly used by teachers a) planning original scientific investigations for students to conduct and b) helping students make predictions from data. In addition to the strategies that Adamson et al. (2013) identified, oral strategies and formative assessment are also often used in science instruction.

Oral Strategies. In a qualitative study examining how elementary teachers use oral strategies during science discussions, three elementary teachers who taught science weekly led science-inquiry discussions in the classroom (Oliveira, 2000). Teachers provided students with research questions and later guided them through investigations for answers. The author identified three categories of oral strategies utilized by study participants: parallel repetition, figurative language, and engaging questions. Some of the figurative language teachers used involved personification, exaggeration, and irony. Word repetitions were the most common type of repetition observed. Finally, engaging questions were mainly used to promote student engagement. Oliveira's (2010) study identified various oral strategies that can be adopted by teachers to assist with guided science inquiry discussions.

Formative Assessments. Teachers employ *formative assessment* in the elementary science classroom to evaluate how each student is learning the concepts being taught and then modify their classroom instruction accordingly to meet the learning needs of all students (Miranda & Hermann, 2015). Formative assessment enables teachers to gauge student understanding of content knowledge, adjust, and adapt their teaching in a manner that helps students develop a deeper understanding and become active participants in their learning. Miranda and Hermann (2015) recommended that teachers integrate formative assessment into the elementary science classroom by asking questions that will illuminate student preconceptions and enable teachers to provide students with feedback, in the form of questions and comments that can be beneficial to their learning process. Another formative assessment strategy involves having students complete exit tickets, or activities that prompt them to reflect on what they learn during the lesson. Lastly, teachers can collect and record anecdotal data based on student observations as a formative assessment strategy to drive classroom instruction.

Ten Core Teaching Practices. Kloser (2014) conducted research that identified 10 core teaching practices. Kloser used a Delphi expert panel research design. Participants were classroom teachers recognized as either national or state science teacher of the year within 5 years of the study being conducted and averaging 23 years of teaching experience. The results of this study were used to identify a set of 10 core teaching practices, listed below, that elementary science teachers can use to help their students master science goals, create an interactive classroom, and foster a learning environment where students are engaged in their natural world.

1. Engaging students in investigations. Teachers should provide students with opportunities to pose questions, collect and analyze data, use evidence to explain, and communicate ideas based on the information gained through the investigation. The goal for these investigations is to help students understand a scientific idea, concept, or practice.
2. Facilitating classroom discourse. Teachers should create opportunities for

students to engage in science talk in the classroom by facilitating both small-group and whole-group discussions. This process enables teachers to establish rules for normal science discourse practices. During the discussions, students can talk about their ideas, evidence, and explanations with others.

3. Eliciting, assessing, and using student thinking about science. Teachers should question students, both formally and informally, to identify their conceptions of scientific practices. Teachers can use the information gained from this practice to guide future science instruction,
4. Providing specific verbal and/or written feedback to students. Teachers should use peer or self-reflection to gauge students' understanding and then offer students' advice about their work and progress made toward learning goals.
5. Constructing and interpreting models. This teaching practice can help students develop explanations for natural phenomena, providing opportunities to better understand science ideas and practices.
6. Connecting science to applications relevant to everyday experiences. Teachers should engage in discussions or activities that connect science to current events, and "integrate the significance of scientific accounts and practices in students' daily lives and the world around them" (p.197).
7. Linking science concepts to phenomena. Teachers should engage students with hands-on activities, real-world occurrences, and investigations that connect to their prior knowledge, providing multiple opportunities for students to develop a clear understanding of the science concepts.

8. Planning meaningful lessons and units. Teachers should provide students with classroom instruction, activities, and assessments that are meaningful. Lessons and units should connect and focus on science ideas that enable students to develop a deep understanding across disciplines.
9. Building classroom community. The classroom teacher should create and maintain expectations for behaviors that will develop a learning community. This community should allow students to discuss their ideas, confusions, or misconceptions, and work together toward mastering their learning goals.
10. Adapting instruction. Teachers should use information gathered during instruction and from assessments, or through the collection of data, to identify students' scientific knowledge and adapt instruction accordingly. Teachers should be able to recognize their students' learning needs and employ instructional methods that meet those needs. The teacher should adjust instruction based on student understanding of concepts.

Summary

The review of the literature for this study began with a description of the conceptual framework section which grounds the study, the seven premises of the National Science Teaching Association Position Statement on Elementary School Science (NSTA, 2002). This conceptual framework informed the study, specifically my interview questions, analysis, and discussion of the findings. The studies reviewed on teacher preparation for teaching science at the elementary level and in-service preparation demonstrated that providing effective science instruction is a challenge in many elementary classrooms, and the under preparedness of teachers to teach K-5 science standards is a central issue (Bergman & Morphew, 2015; Kirst & Flood, 2017; Lewis et al., 2014; Olson et al., 2015; Santau et al., 2014; Steinberg et al., 2015). In many cases, elementary preservice teachers take more reading and mathematics courses than they do science courses during their preservice program (Olson et al., 2015; Steinberg et al., 2015; Trygstad, 2013). However, research indicates that elementary science teachers need to be prepared at the preservice level to teach content standards and implement scientific investigations that will increase students' conceptual understanding (Bergman & Morphew, 2015; Kirst & Flood, 2017; Lewis et al., 2014; Steinberg et al., 2015).

The findings from the literature review on school-based and student-based factors that affect student science achievement at the elementary level showed there are several school-based and student-based factors that have been found to affect student science achievement such as weekly science instruction, teacher experience, and access to resources (Blank, 2013; Johnson & Hill, 2014; Kaya & Rice, 2010; Nowicki et al., 2013; Romance & Vitale, 2012), as well as student socio-economic status of students and their families, home resources, and students' science self-confidence (Blank, 2013; Johnson & Hill, 2014; Kaya & Rice, 2010; Nowicki et al., 2013; Romance & Vitale, 2012).

Research about elementary level science instruction found that there were various instructional strategies that could be used to foster scientific inquiry and understanding of science: hands-on activities, connecting learning to real-world experiences, and addressing difficulties experienced by students during classroom instruction.

Implications

The purpose of this study was to explore the perceptions of elementary school science teachers (Grades 3-5) and principals at eight Title I schools, four of which are high-performing and four are low-performing in science based on results from the SCPASS. This study attempted to understand the difference in science achievement between the HPS and LPS in SSSD by examining teachers' and principals' perceptions of student science achievement, teacher instructional practice, the challenges that teachers face, and the types of resources and support teachers already have or need to succeed. This study also examined how the principals understand the science achievement of the students at their schools, how they perceive science teaching, and how they support their teachers in science teaching. Depending upon the results of the study, one potential project could be ongoing professional development sessions for Title I elementary educators. These professional development sessions would provide teachers with access to materials and resources needed to provide students with high quality science instruction. The sessions would also provide teachers in specific grade levels from both HPS and LPS the opportunity to collaborate with each other offering advice, support, and feedback. Another potential project that could arise from my research findings would be a white paper that would recommend ways that the district could address science achievement in Grades 3-5.

Summary

The problem addressed in this study was the uneven science achievement at Title I elementary schools across a school district. The focus of this study was teachers and principals' perceptions of student science achievement, teacher instructional practices, the challenges teachers face, and the types of resources and supports that teachers already have or need to have to succeed. The perceptions of teachers and principals at four HPS were compared with the perceptions of teachers and principals at four LPS to understand the uneven science achievement at the Title I elementary schools. In Section 1, I described the problem and purpose of the study, provided evidence that the problem existed at the local and national level, and reviewed professional and research literature related to elementary level science education.

In Section 2, I provided a detailed discussion of the research methodology which included justification of the research design, an explanation of the data collection procedures that were used, a description of the process I used to analyze the data, and a description of how I addressed ethical considerations and a description of the process.

Section 2: The Methodology

Research Design and Approach

The research design for this study is a basic qualitative design, which helped to understand the mixed science achievement by exploring teachers' and one principal's experiences with student science achievement, instructional practices used during science classes, challenges that teachers faced, and the types of resources and support teachers used to succeed. Specifically, the principal was asked about science achievement of the students at their schools, understanding of science instruction, and the support for science instruction. A qualitative research method was appropriate because I wanted to understand the experiences and perspectives of individuals who are knowledgeable of the phenomenon (Denizen & Lincoln, 2013; Ravitch & Carl, 2021). Specifically, a basic qualitative design is used to study a local, flexible yet practical problem in the field Ravitch & Carl, 2021). Practitioners inquire about participants' experiences and perspectives of the given problem and interpret these elements in relation to the problem and the setting.

I considered a narrative research design but did not select it because a narrative approach is designed to describe and tell stories about the lives of individuals and their experiences. Grounded theory is a research design used primarily to generate a theory (Creswell, 2012). Because it was not my intention to generate a theory based on the findings of the study, I did not select the grounded theory design. Additionally, grounded theory studies involved sustained time in the field collecting data. I also considered an ethnographic approach for this study. But the goal of ethnography is to describe, analyze, and interpret shared patterns of behaviors, language, and beliefs of a cultural group that develop over a period (Creswell, 2012; Merriam, 2009). I did not select ethnography because the study is not focused on the culture of teachers who teach science at the elementary level.

Participants

Participants were selected based on the following criteria: Teacher participants were third, fourth, or fifth grade teachers who taught science in the general education classroom of Title I elementary schools. Teacher participants had at least 3 years of science teaching experience at the elementary level. The principal participant had at least 3 years of administration experience.

Purposeful sampling was used to select a sample representative of the science teachers and administrators. This sampling frame is appropriate to identify participants who are knowledgeable of the phenomenon (Creswell, 2012). I was intentional in selecting both potential participants as well as the research site. Purposeful sampling allows the researcher to collect data that will produce useful information, and help others learn more about the phenomenon. The final study included four teacher participants representing Grades 3, 4, and 5, and one principal participant. The participants included two fourth grade science teachers, one third grade science teacher, and one fifth grade science teacher. The five educators in this qualitative study representing each of the grade levels as well as an administrator provided the depth needed to yield a range of data on their experiences, perspectives, and knowledge of the phenomenon (Creswell, 2012).

After receiving permission from Walden’s IRB (02-12-19-0400044), I submitted a Request to Conduct Research application to the school district's Office of Assessment and Evaluation via electronic Google form obtained from the district website for permission to use a district compiled list of email addresses for Grade 3 to 5 teachers as well as principals and assistant principals employed by the eight study schools. Then I contacted the principals of the eight study schools via email to determine the teachers, principals, and assistant principals who met the selection criteria. After the teachers and administrator who met the selection criteria were identified, I sent individual email participant invitation letters and included a copy of the informed consent agreement to the prospective participants. The email invitations explained the purpose of the study; its importance; the protection of their privacy and confidentiality before, during, and after the study; and an electronic consent form. Potential participants confirmed their participation by email. Two weeks after the initial individual email invitations were sent, I sent a final email invitation to any prospective participants who had not yet replied to the first electronic invitation. After all consent forms had been received, the four teacher participants were contacted to schedule a location, date, and time for a face-to-face interview or a date and time for a phone interview.

Participant invitations were sent to the four principal participants of the eight study schools via email. The same procedures used for the teacher participants were used to invite principals. I also included a phone number for those who wished to confirm their participation by phone rather an email. After 1 week, the principal who reviewed the invitation and returned the consent form was contacted via email to schedule a location, date, and time for the interview. One face-to-face principal interview participant was asked to choose a location that had minimal disruptions and afforded the opportunity to maintain participant confidentiality.

I established a researcher-participant working relationship with the participants prior to the study by establishing a positive rapport with the participants. I called the research participants prior to their interview to introduce myself, confirm the interview appointment, explain why I conducted the research and what I hope to learn from them. The foundation of this working relationship was creating an environment that was built on trust, honesty, and transparency so that the participants felt comfortable sharing their experiences, perspectives, and knowledge knowing their information would remain confidential. I explained my obligations to them as a researcher and their obligations to me as a participant.

Throughout the study participant rights and confidentiality were protected. To protect participant confidentiality, each participant was assigned an alphanumeric code so that their identity remained confidential. For example, a teacher participant would be labeled as T1, T2, T3, and so forth. Additionally, prior to the interview, each participant was provided with an electronic informed consent form that stated the purpose of the study, a statement on the voluntary nature of the study that included the option to withdraw at any time, minimal risks and potential benefits of participating in the study, statement of confidentiality, contact information if any questions arise, contact information if there are any questions or issues about participants' rights, and consent to participate in the interview. Participants did not receive any form of compensation for participating in the study. Moreover, audio files, transcripts, and data analysis documents are stored on my password protected laptop. Five years after the completion of my project study all documents, electronic files and recordings will be permanently deleted, and all paper documents will be shredded.

Data Collection

All qualitative studies require access to data from qualified participants. For a basic qualitative study, only one data set is used: interviews (Patton, 2015). In qualitative research interviews are the most common form of data collection (Merriam, 2009). Interviews are needed when trying to gain information from another person's perspective (Patton, 2015). Conducting in person or phone structured interviews provided the data needed to gain insight into elementary educators' perspectives teaching science in Title I elementary schools.

For my study, I used an interview protocol based on the elements from the conceptual framework and the related literature (see Appendix B). The 12 question-interview protocol allowed me to gain more insight into the participants' perspective of science instruction. The interview questions were structured but participants were not limited to a set fixed of answers as seen in the traditional closed-interview protocol (Gubrium, 2012) and I asked follow-up questions based on participant responses. The sequence of questions was developed from broad to more specific and complex (Billups, 2012) that provided more data about the educators' perspectives, experiences, and perceptions to best answer the research question.

The qualitative data that were collected from the educators was a way to obtain detailed information as well as a wide range of diverse perspectives of the educators about science instruction in Title I elementary schools. The participant interviews along with the sample size provided sufficient data necessary to answer the research question by focusing on the descriptions of the participants' experiences (Flick, 2018).

I scheduled a one-on-one phone call with each participant to discuss the purpose of the study, participant confidentiality procedures, and to set a time and place for conducting the actual interview. To protect the privacy of the teacher and principal participants, phone interviews or face-to-face interviews were conducted outside of their school site at an agreed upon location that was both convenient for the participants and suitable for recording, such as a meeting room at a local library. Interviews were conducted individually, either face-to-face or by phone, and were recorded using a digital recorder. The interviews were scheduled for approximately an hour, but interviews ranged from 7-27 minutes. I conducted the interviews using an interview protocol that I developed to guide the interview (see Appendix B), which was structured though participants were not limited to a set fixed of answers as seen in the traditional closed-interview protocol (Gubrium, 2012). The sequence of questions was developed from broad to more specific and complex (Billups, 2012) that provided more data about the educators' perspectives, experiences, and perceptions to best answer the research question. As needed, I used probes when clarity or expansion of their responses was needed. The same procedures were used for the phone interviews.

During the interviews, I recorded handwritten notes in my research notebook. The research notebook was used to record my observations and the conditions of the interview. I also used the research notebook to document any thoughts or ideas developed during the research process as the data emerged. After the completion of each interview, I transcribed the participants' responses from the audiotapes by hand into a Word document. Once each interview had been transcribed, I checked each transcription against the recording to ensure the transcription accurately represented the recording. Additionally, I removed words that carry no meaning, such as, "um, uh, like," and so forth. Using this transcription method built my familiarity with the raw data since I listened to each recording multiple times. To further check the accuracy of the transcription, I emailed participants a transcript of their interview responses and asked each participant to review their transcript and confirm that the transcript represented their responses to the interview questions I asked participants to reply to my email within 5 days.

In a qualitative study, the researcher is responsible for collecting, analyzing, and reflecting on the data collected in the study. I have been teaching in the school district for 6 years as a teacher in a non-Title I elementary school, and 2 years in a Title I elementary school. I taught fourth grade for 6 years and served as the grade level lead teacher for 2 years. When asked to serve as a third-grade co-teacher at one of the Title I elementary schools, I accepted the position, teaching mathematics and social studies. This Title I elementary school is one of the study schools in my project study. I have attended a few workshops with my co-teacher and some of the teachers I invited to participate in my project study, but I have not worked directly with them. In addition, I have no supervisory duties or responsibilities over the participants. To manage my biases as a researcher, I selected participants who were knowledgeable of the phenomenon being studied and had a wide range of teaching experience in the grades that were included in the SCPASS assessment.

Data Analysis

Inductive analysis was used to analyze the interview data, meaning themes emerged as I analyzed the data (Bingham & Witkowsky, 2022). Data analysis included coding the data, identifying patterns, developing themes, explaining the findings, reflecting on the results, and checking the validity of the results (Creswell, 2012; Lodico et al., 2010). During this inductive process, I chunked the data into smaller units using two passes to summarize the coded concepts. At this stage, I condensed the concepts into themes then incorporated the framework and related literature to interpret the themes to answer the research question.

Coding

Coding is the process of organizing data into chunks or segments to reveal a first level of meaning from the data (Creswell, 2012; Lodico et al., 2010). Before coding began, I copied and pasted participants' responses into separate Word documents and identified each document with the corresponding alphanumeric code. This was done for ease of retrieval of the stored transcripts. The transcript label was helpful when I compared the transcript to the audio-recording.

The first step in coding the data was to read the interviews multiple times. During the first reading, I read the transcripts for meaning. During subsequent readings, I made margin notes and entered comments in my researcher journal as reminders or points to consider when coding the data. This process is recommended prior to coding data so I can familiarize myself with the data (Braun & Clarke, 2019).

Open coding, sometimes referred to as initial coding, was used to analyze the interview data (Saldana, 2016). I chose this strategy because this is a starting point to explore the data. These codes are temporary and may be altered as analysis develops. During open coding, I searched for repetition of words, phrases, and/or concepts. I conducted line-by-line open coding for individual transcripts by highlighting repetitions (GREEN represented technology tools for instruction, BLUE was mastery of science content, YELLOW was teaching methods, and RED was instructional materials) that reflected participants' beliefs and experiences, then I searched for and grouped similarities across transcripts. Once similarities were found, I wrote a label which gave meaning to the grouped open code as mentioned above. Appendix C contains a list of the codes, corresponding transcript excerpts, and participants' identification.

Following open coding, I searched the chosen framework and related literature for concepts related to science instruction. Those concepts were critical to support the findings and were useful in developing themes (Linneberg & Korsgaard, 2019). Once temporary themes were determined, I reread the data and the themes to ensure they answered the research question. I collapsed several codes to develop two themes. The two themes that emerged from the data are (a) elementary teachers used contracted resources, collaborative planning, a variety of teaching methods, instructional materials, and technology tools during instruction to improve student achievement in science, and (b) elementary teachers incorporated several assessment methods to monitor student progress toward achievement of science standards. For this study, the data collection and analysis were guided by the perspectives of five upper elementary educators' teaching science to improve achievement in Title I elementary schools. After completing the data analysis, no discrepant data were found because there were no conflicting data with the themes.

Evidence of Quality

Validity and reliability are two important components of the research study. Rich, thick description is a strategy I used to maintain reliability and validity of my findings. The data that I collected helped provide a deep understanding of the educators, science instruction and achievement, their experiences and perspectives and their knowledge of the phenomenon. Another strategy that I used was reflexivity. Throughout the research process, I used a researcher's journal to engage in self-reflection about my beliefs and biases. I noted any of my biases so that I did not allow them to influence my data collection and/or data analysis.

Data Analysis Results

The purpose of this study was to explore five upper elementary educators' perspectives of science instruction to improve achievement in Title I elementary schools in a Southeastern state. I conducted three individual interviews and one group interview with four elementary science teachers in Grades 3-5 and one elementary principal. In the proposal, all interviews were individual. I chose to conduct a group interview because the two teachers were co-teachers who plan and teach science together in the same classroom.

To analyze the data inductively, I conducted one coding cycle using open coding.

Inductive analysis with open coding aligns with the research method and design – a basic qualitative design. In the following narrative, I described data analysis in detail and provided samples of participants' transcript excerpts to document and support the findings. I detailed only the findings that answered the research question.

From my analysis, two theme statements emerged, which are (a) elementary teachers used contracted resources, collaborative planning, a variety of teaching methods, instructional materials, and technology tools during instruction to improve student achievement in science and (b) elementary teachers incorporated several assessment methods to monitor student progress toward achievement of science standards. I will present each theme statement and supporting codes and transcripts to describe participants' perspectives of their experiences teaching science.

Description of the Research Site

Science instruction was the central phenomenon for this study. Part of the reason for this study was the concern over elementary students' science performance on formal science tests. Several points about the school emerged from the opening interview questions: formal assessment results, time for science instruction, and student preparation and science instruction.

According to the participants, student performance on formal science assessments varied throughout the years science was tested. In one school, students' science performance decreased from the previous year; however, the results remained high. This experience was not shared among all the participants. There were changes that occurred throughout the test years that teachers believed effected test outcomes, such as, teacher turnover, changes in science materials, teaching to the standards, home environment and the high crime rate. Teachers were not probed how these factors may have affected test scores. Teachers did express that the time to teach science ranged from 40-60 minutes per day. One teacher taught a science block of 2½ hours per week. Teachers were not asked whether time was a factor in improving science test scores.

The principal in this study was concerned about the test results and science instruction. “A lack of scientific inquiry skills and being able to problem solve” was attributed to the test results. Additionally, the principal attributed teachers showing “videos and telling and talking and not enough doing” to students’ science performance. The principals recognized challenges in the effectiveness of science instruction; however, educators are determined to improve science instruction and ultimately student performance.

Theme 1: Elementary Teachers Used Contracted Resources, Collaborative Planning, a Variety of Teaching Methods, Instructional Materials, and Technology Tools During Instruction to Improve Student Achievement in Science

Contracted Resources

Contracted resources were used by the elementary teachers to teach science. Two teachers, T3 and T4 stated that school district had invested in hands-on resources to help teachers instruct science units and students learn the corresponding content. Not only are teachers provided with hands-on materials, but they can attend workshops to guide them with their instruction when using these materials. The notion behind these contracted resources is not only to give students specialized knowledge, but to create a learning environment that is interactive. T3, a third-grade teacher, also noted that two resources: "MadLab Science and High Tech High Touch…were correlated with our science standards." T4, who taught fifth grade, added these contracted resources included people as well as materials:

> They [High Tech High Touch] come to our school, and they [High Tech High Touch] do a lesson. It's usually one person comes, and she sets up the lab with help from some of our staff. She guides the kids through, first, a written portion where they had to make a Four-Square model, which is what we use in writing. As well, the kids take notes, and she gives a lesson on whatever they're [students] going do an experiment on that day. Then she guides them [students] through an experiment or through centers where they're [students] doing multiple activities.

Contracted resources are beneficial for both the classroom teacher and the students. Experts in specific science topics share their expertise in teaching the content, which is modeled for the science teachers, who, in turn, would apply this instruction in their classes. Also, students have their interest peaked in specific science topics which could lead to science careers as they continue through their education (Babarovic, 2022; Morgan et al., 2023; Parker et al., 2020; Peterson, 2020). An additional benefit is the possibility of opening science careers for female students (Nation et al., 2019; Stevenson et al., 2021). These benefits are critical in motivating teachers and students to view science as an area of interest to pursue academically and potentially as professionals. It remains to be seen whether contracted resources will improve science achievement at the research site.

Collaborative Planning

Collaborative planning was encouraged by the principal and an integral part of science instruction for three science teachers. The principal had instructional coaches attend grade level meetings to help with collaborative planning. “They [instructional coaches and teachers] talk about instruction and talk about the standards that they [teachers] are teaching. They [instructional coaches and teachers] talk about how they’re going to assess those standards.”

Not only was collaborative planning conducted with instructional coaches, but science teachers also met to collaborate. T2, a fourth-grade teacher, said that “We [teachers] do team planning, and we bounce ideas off each other for different resources for students.” Collaborative planning was not restricted to science teachers. Professional learning communities and cross-grade planning were part of the collaborative planning process. T2 shared,

> We [teachers] have a PLC meeting at least once a week where we [teachers and admin staff] talk about different curriculum and goals.
>
> We [teachers] also plan one day with the fourth-grade team of teachers. We [teachers] make sure that we’re [teachers] on the same page. We [teachers] discuss things that we’re [teachers] struggling with and how we can fix what we’re struggling [with] so the lessons flow more smoothly.

T3 practiced collaborative planning with a coteacher. When T3 plans with the coteacher, they “think about all aspects of the [science] unit as a whole.” This experience can vary from a high to low experience teaching science.

Collaborative planning, also known as team planning, involves two or more individuals who desire to maximize success for student learning (Bendtsen et al., 2022; Davidson et al., 2023; Ronfeldt et al., 2015). Regardless of who was on the collaborative team, the goal is to identify the instructional and learning needs, materials, and content required to teach science lessons (Borowski & Rupe, 2023; Gelfuso, 2021; Gutierez, 2021).

Variety of Teaching Methods

All science teachers used a variety of teaching methods during science instruction, which included an assortment of written, oral, and hands-on experiences where students could share their scientific knowledge. T2, T3, and T4 had their students develop and present oral and written reports and projects. T2 stated that "we're working on our team building and working together skills at the moment. We [teachers] like to implement those team-based projects in the classroom."

Students' oral skills were emphasized and used to demonstrate student knowledge. T2 confirmed using oral experiences: "We [teachers] do a lot of turn-and-talking to make sure the students are understanding what we're [teachers and students] learning." T2 works with a team of teachers who employs turn-and-talk during instruction.

T3 used a combination of written and oral learning experiences in a closing activity of a lesson. Each student was expected to write an observation, then share orally what was observed. Students would express excitement if their observations were different from their classmates. Not only were students motivated in learning the science content, but their time also-on-task increased.

Teachers taught using both whole group and small group instruction, hands-on activities, and teacher modeling or demonstrations. Whole group instruction was used at the beginning of the school year with the intent of moving towards small group instruction. T4 used whole group instruction to show videos but preferred small group instruction to determine student learning. Teachers 3 and 4 designed and managed science centers or science stations. Students would rotate through these in small groups completing different activities. T3 described how science stations were used to teach a unit on electrical energy that featured technology and a 5-minute minilesson.

> we [teachers] had one afternoon that we wanted to do something really engaging with the students. We wanted to have different stations. I think the unit was back at the beginning of the year when we [teachers] were talking about electrical energy. We wanted to have a few different stations where one of the groups was at the SmartBoard and one of the groups was putting together some circuits to make a lightbulb light up.
>
> We [teachers] had a couple of different stations and I just remember teaching them the 5-minute minilesson of reviewing the content from the day before.

T4 managed centers to teach science content. This teacher believed that student behavior and science knowledge improved when using centers. Students were motivated to learn the content when T4 announced that they would working in science centers:

> I have about four to five centers in the classroom. We [students and teachers] do a variety of activities where they [students] rotate throughout the centers. That has

> improved their test scores as well as just the general behavior and the way that they feel about science. They're not dreading it. They look forward to it. Whenever I say we're doing centers, they get excited. It's been more fun to teach it that way as well.

All but one teacher (T1) mentioned using of the various teaching methods described above. Only one teacher (T4) stated that one of the instructional methods improved science performance. The principal favored student-centered instruction over teacher-centered instruction. Students need to receive science instruction in a variety of instructional methods to successfully understand and learn concepts (Harshbarger, 2019; Kara & Kinger, 2022). Modeling and engaging in scientific discussions promote scientific understanding and supports conceptual understanding (Kara & Kinger, 2022; Soysal, 2021). Small group instruction, collaborative discussions, writing about science and engaging in hands-on experiments promote critical thinking and problem solving, extend learning, and enhance student understanding of scientific concepts (Harshbarger, 2019; Kara & Kinger, 2022).

Instructional Materials

Various instructional materials were used by all teachers to teach science. T2, T3, and T4 use FOSS kits when teaching science. T2 stated that "we're able to put together lessons that worked and the experiments that worked for our students, which helps us better teach the science standards." T2 described the components of the FOSS kit:

> It's [science kits] based off each of standard that we teach. It gives us different experiments and examples for students, and then we also have our student science

books, and other curriculum resources that we use to help us [teachers] guide and teach the science standards."

T4 noted the benefits of the FOSS kits:

The FOSS science kits that from the district have a lot of activities that are aligned directly from the standards. They come with the teacher's manual and also usually student workbooks or student reading material. [They include] all the materials that we [students and teachers] would need in order to perform those experiments."

Not only are Foss kits used during classroom instruction, but teachers ensured that they incorporated manipulatives and science tools in their science instruction (T2, T4). These were used while teaching science standards during specific units of study. T2 used science tools during a unit of sound: "They [science kit] had different sound tools in this unit. They [students] did get to manipulate the different science tools and experience the wavelengths and the sounds with different tools from that [science] kit." While studying weather T4 stated "When we [students and teachers] did weather tools, we …actually got to use the weather tools outside."

Teachers used student science textbooks and other curriculum resources while teaching science. T2 described how she uses science books and curriculum resources: "…we [teachers] also have our student science books, and other curriculum resources that we use to help us guide and teach the science standards. We [teachers] also have the CCSD curriculum online that we [teachers] look for activities for." T3 noted that "The science textbook, *Interactive Science*; chunks down [breaks down science information] very well. It gives the children exactly the information what they need." T4 only uses the science textbook at specific times during the lesson: "I'll have them [students] pull it [science textbook] out if we do have whole group instruction. Maybe at the beginning [of a science lesson], as a short intro or something."

Teachers 2 and 4 used TIME Magazine articles as instructional materials to make real world connections when it related to science. T2 stated that "We [teachers] do use a TIME Magazine. When it does relate to science, we will pull that into our science time so that they [students] can get the experience with an actual magazine and the different articles in there."

T4 described how she uses TIME magazines strategically to tie in real-world science when students are not engaged in direct instruction.

> We [teachers] have some TIME magazines that we've been getting at school. When they [students] finish a test early or something, they can go and get one of those magazines. They're always there on the shelf for them to have access to after they're finished with the test. Sometimes during ELA, we'll say, "Hey, go pick one of those up," just to get them a little bit more kind of real-world science exposure.
>
> When they get those [magazines], they come over to me. "Hey, I found this in the magazine. This is from what we were learning directly." That's been kind of cool too, because one, you know that they're [students] actually reading, and two, they're [students] making those connections with the real world in science.

Instructional materials and educational resources are used to facilitate learning cater to multiple learning styles and are effective ways to teach elementary science (Apat, 2022; What Works Clearinghouse, 2020). Curriculum materials like science books can promote comprehension of scientific concepts and engage students in science learning (Lai & Chan, 2020). To experience meaningful learning, science students should be engaged in a variety of materials and activities (Zinger et al., 2020). Scientific investigations or experiments include the use of science tools and manipulatives and - provide students with the opportunity to learn science through exploration and improve their understanding of science concepts (Apat, 2022; What Works Clearinghouse, 2020; Zhang & Van Reet, 2022; Zinger et al., 2020).

Technology Tools

Technology tools in science enhance teaching and learning, engage students in the learning process, and promote curiosity and inquiry. Teachers 1 through 4 incorporated several technology tools for science instruction: Socrative, Flocabulary, the SmartBoard, BrainPop, iPads, and videos. Two teachers, T1 and T2 stated that they use Socrative to assess students content knowledge. Socrative is an interactive web-based student response system that allows teachers to create quizzes for students to answer in multiple-choice, true/false or short-answer questions. The quizzes are automatically scored and the results can accessed in real-time. The data collected from Socrative can be used to guide instruction (Socrative, 2023; Socrative review for teachers, n.d.). T1 shared, “Most of our tests to check their [students’] understanding is done through Socrative.” T2, a fourth-grade teacher, uses Socrative for student assessments as well stating “…just short quizzes using Socrative.”

Technology, specifically internet-based programs and resources, such as BrainPop and Flocabulary, were used by T2, T3, and T4 for a variety of instructional purposes including reviewing content and assessing students' content knowledge for science instruction. Flocabulary contains videos and songs to present academic content to students. The activities are designed to help students learn vocabulary and key concepts as well as review learning and can be completed independently or as a whole group (Educational hip hop, n.d.; Flocabulary review for teachers, n.d). BrainPop uses animated movies and activities to support science topics (https://www.brainpop.com/)

T2 used Flocabulary to review weekly content stating,

> At the end of the week, we [teachers] do a recap. We actually use Flocabulary for that, and they [Flocabulary] have a recap of current events that's going on in the world. T3 used BrainPop, an internet-based resources, as a science teaching tool during the instructional week. T4 shared "I use BrainPop…and Flocabulary as well.

Technology devices were used with the intent of fostering student engagement during science instruction and using the devices to access internet-based applications to conduct research during science instruction. iPads and SmartBoards were used in classrooms of Teacher1, Teacher 3 and Teacher 4. T1 uses the iPad for students to conduct research during science instruction. T1 stated

> We [teachers] incorporate science with our writing time for research aspects with different topics. The students will go on their iPad and use a research-based website called PebbleGo. The students will look up different facts and

> information about their research project that's pertaining to science and writing standards.

T3 and T4 incorporate iPads and a SmartBoard into the learning environment. T3 described how the iPads are used during an animal studies unit.

> All of our students have iPads and teachers have iPads. We [students and teachers] use our SmartBoard. What I will do for example, for online habitat building, I could load on their [students] iPad the resource that they [students] need and they [students] can play [online habitat building program]…

T4 uses the Smartboard in conjunction with the iPad during science to enhance learning as well as review content mastery. "Kahoot is an interactive game that we do on the SmartBoard. The questions come on the screen, and they pick the answer on their own individual iPad."

Technology based applications and programs are beneficial for teaching and learning science. Incorporating multimedia tools, like videos and other software, increases student engagement. Teachers, who use technology during instruction, have access to a plethora of resources that go beyond the reach of the traditional science textbook. Using internet-based resources during science instruction allows for easy distribution of information (Menon et al., 2020; Ramasundrum & Sathasivam, 2022). An additional benefit is providing teachers with opportunities to scaffold student learning as well as providing immediate feedback to teachers and students (Ramasundrum & Sathasivam, 2022). Technology tools for instruction support meaningful science learning (Constantine & Jung, 2019; Ramasundrum & Sathasivam, 2022).

Theme 2: Elementary Teachers Incorporated Several Assessment Methods to Monitor Student Progress Toward Achievement of Science Standards

Mastery of Science Content

Formative Assessment. Formative assessments (quizzes, observations, and class discussions) and summative assessments (tests) were used by three teachers and encouraged by the principal as ways to monitor and ensure student mastery of science concepts. Observing students in their learning environment is a way to collect data on students' understanding of the academic content. Three kinds of formative assessments were used during science units of instruction to collect data and gauge how well students were grasping the science standards as they were being taught. Teachers used summative assessments to assess student mastery of science standards at the end of each science unit.

Formative assessments were used during science instruction to monitor how and whether students were progressing toward mastering the science objectives that were being taught. T1, a fourth-grade teacher, said that "We do quizzes throughout [the science unit of instruction] to make sure the students are grasping the content." Quizzes vary in number based on method of integration. T4 incorporated quizzes into her science instruction during each science unit which lasts about nine weeks, "probably around two to four quizzes throughout."

Listening and observing students while they are engaged in learning activities is a formative assessment that can be used to make instructional decisions. Observations give teachers a chance to see students learning in their natural environment. It also allows teachers to collect evidence of students' progress toward mastering learning objectives.

Teacher 3 incorporated observations as a formative assessment during her science instruction. T3 shared, "I'll take one [assessment] daily just observing them working with the material."

Teachers 3 and 4 used class discussions as an additional way to monitor student mastery of science content. Teacher 3 incorporated class discussions during science investigations and experiments: "We'll [students and teachers] do a class discussion of it [results from science activities]…of what they found." Teacher 4 used small groups as a time to talk with students about their learning: "When I have three to four students at a table with me and I'm asking them direct questions and we're having discussions, I can gauge right there if they're [students] getting it [science information being taught] or not."

The principal had instructional coaches meet with teachers to discuss student learning and how they would be monitored using formative assessments.

> They [instructional coaches and teachers] talk about how they're going to assess those standards. They talk about making sure the assessments have higher level, lower level, middle level test questions on there to make sure kids have a true understanding of what they're [students] trying to learn.

Summative Assessments. Summative assessments, or end of unit tests, were used to track student knowledge and mastery of science concepts, typically at the end of a 9-week instructional science unit. T1, T3 and T4 administered formal, summative assessments once per unit as outlined in the science curriculum. The summative assessments that were administered to students at the end of the science units were provided to teachers by the school district. These assessments were administered to students once all standards and objectives for the science unit were taught.

Assessments are designed with the purpose of providing an understanding of student knowledge and thinking. The data collected from assessments should be used to improve classroom instruction (Dini et al., 2020; Keeley, 2019). When used in elementary science assessments are vital to monitoring increasing student knowledge and understanding of scientific concepts as well as ensuring students are mastering the appropriate science standards.

Limitations of the Findings

The findings are limited because of the small sample size and the interview questions. Although more than five participants were interviewed, only five participants' data were analyzed. The interview data from the other respondents were accidentally deleted from the entire data set. Five participants, a small sample size, are sufficient if the interview protocol is indepth in nature (Creswell, 2012; Merriam, 2009). For a basic qualitative study, five participants restrict the findings and transferability to other settings (Aslan, 2023; Creswell, 2012; Merriam, 2009); only settings with a similar problem, circumstance, and sample would suffice.

The interview questions were not open-ended, and no probing or follow-up questions were used to elicit in-depth responses from the participants. Open-ended questions are used in qualitative research because the researcher does not want to limit participants' responses and desires for respondents to share knowledge of the phenomenon under study. These questions are used to explore respondents' views, perceptions, and experiences plus complicated and varied topics (Altun & Nayman, 2022; Aslan, 2023; Creswell, 2012; Darici, 2023; Merriam, 2009). Researchers use probing and follow-up questions to clarify, elaborate, and demonstrate or describe responses already given by a participant. These questions take interviewing to a deeper level of inquiry. In this instance, many of the questions were closed, resulting in narrow responses to specific points.

Evidence of Quality

Rich, thick descriptions is a procedure that I used to add to the validity and reliability of my study. Rich, thick descriptions include detailed accounts of participants' experiences, the situation, and the sample. It also ensures the quality of a study by including the participants' views in addition to the researcher's interpretation of the participants' views in connection to the context of the study (Creswell & Báez, 2021). Rich, thick description included transcript excerpts from the interviews I conducted with the participants. Another way I used rich, thick descriptions was by presenting the data in a detailed specific narrative.

I used reflexivity to acknowledge and address my own biases and assumptions. I provided a statement on my educational background and experience as an educator and researcher. I reflected on my assumptions and biases and how they could influence the study throughout the research process. This included keeping a reflexive journal and soliciting feedback from participants to ensure the interpretations were validated.

Summary of Study Outcomes

Data were reviewed and analyzed from all participants, resulting in two themes. Theme 1 was that elementary teachers used contracted resources, collaborative planning, a variety of teaching methods, instructional materials, and technology tools during instruction to improve student achievement in science. Theme 2 was that elementary teachers incorporated several assessment methods to monitor student progress toward achievement of science standards.

Theme 1

Elementary teachers used a variety of teaching tools, science resources, and instructional methods and techniques to teach the science standards and content. Only two teachers (T3 & T4) used contracted resources, which were supplied in the school district. These two teachers also took advantage of professional development opportunities to develop and perfect their skills using these resources. It is unknown why T1 and T2 did not take advantage of these resources of professional development opportunities and is worth investigating possible reasons for these omissions in the future.

As mentioned above, both the contracted resources professional learning opportunities are helpful for instruction and student learning. Science experts model how to teach the subject matter and teachers pattern their instruction after what they have observed to students in their classes. This feature of contracted resources is supported by this study's conceptual framework – the three dimension of concept science (Pratt, 2013).

Pratt asserted that scientific and engineering practices coupled with disciplinary core ideas are essential for science learning in the K-12 setting. However, it is imperative to consider the advantages and disadvantages using contracted resources before implementing them. One of the advantages is the flexibility of their uses. They can be used in any subject area, for any age group, and incorporate real experts in the field of study (Alieksieieva et al., 2023; Böschl et al., 2022). In contrast, there may be a challenge in using contracted sources. Classroom teachers know their students' strengths and weaknesses and can adapt instruction to those academic needs; whereas the content expert does not have the academic background of students and may teach the content from their knowledge of the concepts (Böschl et al., 2022; Zorlu & Sezek, 2020). Careful consideration of specific topics and the student base may need to be pondered before delving into using contracted resources. This may lead to collaborative planning among the content expert and classroom teachers.

Collaborative planning was supported by the principal and adopted and implemented by three science teachers. The principal employed instructional coaches to link instruction to the science standards during team meetings. At other schools, teams of science teachers met to collaborate during the planning stage and infused collaborative planning in learning communities and across grade levels or with a coteacher. It is interesting to know that contracted resources – content experts – were not included in collaborative planning.

Collaborative planning, sometimes called coplanning, was used predominantly in inclusive classroom settings with the general and special education teachers working together to meet the needs of diverse students and to meet the legal criteria for diverse students (Alsarawi, 2019; Kuntz & Carter, 2021). This planning strategy has evolved to include teachers across subject areas and grade levels with the intent to improve student learning and academic achievement (Alsarawi, 2019; Eshchar-Netz & Vedder-Weiss, 2020; Gutierez, 2021). The notion of collaborative planning is supported by the framework. Pratt (2013) noted that scientific and engineering practices, one aspect of this dimension, is completed when scientists access others' expertise. When used in science, teachers at the research site involved subject teachers and cross-grade collaborative planning and reflects what happens in the real world. I would recommend using this strategy in science and across all subjects at the elementary level.

Not only was collaborative planning evident in the science classrooms at the research site, but science teachers also used a mixture of written, oral, and hands-on experiences to teach science standards. Students oral and written reports and projects were assigned so they could communicate their technical science learning. These tasks had positive results in students' engagement and science understanding.

Grouping – whole and small – was used to deliver instruction through teacher modeling or science demonstrations. As mentioned above, whole group instruction was used at the beginning of the school year with the intent of moving towards small group instruction. Whole group instruction featured introducing new content at the beginning of a science unit and showing videos aligned with specific content. Small group instruction included science stations where students completed activities in student teams. One teacher observed improvement in student behavior and scientific knowledge using centers. Students were engaged in discussions that moved students from literal knowledge to a higher degree of thinking about science. Such instruction or grouping strategy is evident in student-centered instruction, which the principal in this study advocated.

There is a place for whole group and small group instruction in science classrooms. Researchers (Harshbarger, 2019; Kara & Kinger, 2022) recommend employing a variety of instructional methods. As in the science classrooms in this study, teacher modeling or demonstrations and student engagement in scientific discussions stimulates logical and abstract understanding (Kara & Kinger, 2022; Soysal, 2021). The instructional methods used by the teachers in this study and advocated by the principal, endorse critical thinking and problem solving, extend learning, and enhance student understanding of scientific concepts (Harshbarger, 2019; Kara & Kinger, 2022).

It is interesting to note that grouping students is recommended in education (Kanika et al., 2022; Tereshchenko et al., 2018; Wang et al., 2021). Grouping is not groupwork but a strategy to assist students in learning content. Groups should be flexible in size and makeup, subject to change, and based on the intent of the lesson. Teachers, who use grouping effectively, can randomly select group participants, select groups by homogenous or heterogenous learning levels, choose students based in their interests, topic knowledge, or skills, or have students select who they prefer in their group. The purpose of using student grouping is to encourage student engagement, active learning, higher-order thinking, effective communication, and effective decision-making skills. It must be noted that student grouping requires teachers to plan and facilitate groups with care; otherwise, the learning objective will not be attained.

Teachers not only varied their instruction in the science classroom, but they also used various instructional materials to teach science standards. FOSS kits were purchased for classroom use and were aligned with the science standards teachers were required to teach. These kits included experiments and examples for teachers and students to complete and use, a teacher's manual, and student workbooks and related reading materials. Additionally, teachers had access and incorporated manipulatives in specific science units, such as weather. Scientific reading of the science textbooks and related articles from the TIME magazine helped students understand content plus real-world applications of science.

Elementary teachers must be aware of content, vocabulary, and scientific style of writing educational materials and resources. Science books are written by experts in the field who do not know their audiences; therefore, it is important for science teachers to be teachers of reading (Kim & Snow, 2021; Moats, 2020; Paige et al., 2021; Pratt & Coleman, 2024). Students should be guided to speak and think like scientists, and this includes reading scientific reading materials. Additionally, textbooks have specific features that assist the reader, such as captions, tables, and text features. Scientific authors help readers by noting specific vocabulary that is critical to the content. Terms that are used in science may be used differently in other subject areas. These elements must be purposefully taught to comprehend the texts; therefore, I recommend teachers engage in content area reading strategies that feature comprehension, vocabulary, and text formats.

Teaching content areas strategies for vocabulary and comprehension are supported by this study’s framework. Pratt (2013) mentioned that cross-cutting concepts and disciplinary core ideas are part of K-12 education. As mentioned above, scientific terminology may be used in other content areas, and is part of science core ideas. Ignoring these strategies will affect student learning and academic outcomes.

Teachers at the research site also used software and hardware technology tools to enhance and assess student learning. Students use technology for personal and educational purposes; therefore, they are familiar with using technology for enjoyment and learning. The teachers in this study were proficient in selecting and incorporating technology during their instruction.

Teachers 1-4 used Socrative, Flocabulary, the SmartBoard, BrainPop, iPads, and videos. Socrative was used to assess student knowledge and guide instruction. BrainPop and Focabulary were used to review content and assess student knowledge. Animation was featured in both web-based tools. Students were assigned iPads and were instructed to use PebbleGo, a research-based website, to explore specific topics when developing a research project. iPads were linked to the class SmartBoard. Teachers might use an application loaded on their iPads and demonstrate how to complete a specific task students can complete independently. Kahoot, an interactive game, is also loaded on the SmartBoard and students’ iPads. This application was used to review science content for mastery.

One aspect of incorporating technology in science instruction is the notion that students are at liberty to investigate a topic beyond what is covered during instruction.

This is no more evident than in science, technology, engineering, and mathematics (STEM) learning (Aydin, 2020; Boz, 2023; Erkan & Duran, 2023; Movahedazarhouligh et al., 2023). Students are exposed to integration of these four entities in day-to-day experiences. They have opportunities to enact being scientists, increasing problem-solving skills, exposing them to higher-order thinking, and feature collaborative learning with adults and peers. Teachers can identify and support students who exhibit and desire a depth of learning. I recommend using STEM learning in elementary science classes to develop science learners, which might lead them to careers in STEM.

Theme 2

Elementary teachers incorporated formative and summative assessment formats to monitor student progress toward achievement of science standards. Quizzes, teacher observations, and class discussions were formative formats, and chapter and end-of-unit tests were summative assessments. Assessments, regardless of the formats, were used to assess science objectives standards at varying points throughout the chapter or unit, make instructional decisions, gauge students' mastery of content.

There is more to assessment than assessing standards, making instructional decisions, and gauging students' master of content. Teachers' knowledge and use of assessments depends on their assessment literacy, which includes teachers' expertise and familiarity of assessments needed to evaluate and verify student learning (Dayal, 2021; Koenka, 2020; Kula-Kartal, 2022; Wilkinson, 2024). Xu and Brown (2016) developed a framework for understanding teachers' assessment literacy. In their framework, the authors narrowed assessment literacy to knowledge and skills, assessment education, and contextual considerations. Knowing about teachers' literacy assessment, as applied in science, would be beneficial as teachers assess student knowledge and determine whether standards are met. Including literacy assessment in teachers' repertoire of assessing students would lead to teacher self-reflection of assessment practices, participation in the assessment process, and including students in assessing their progress.

In reflecting on the themes and gaps in teachers' practice in science education and assessment, a white paper for teachers and administrators at the research site. In this white paper, I would include what has worked and recommendations that address gaps in practice in science and the outcomes of my study. I recommend the following:

1. Content area reading strategies that feature comprehension, vocabulary, and text formats.
2. STEM learning in elementary science classes to develop science learners, which might lead them to careers in STEM.
3. Literacy assessment provide indepth understanding of student performance.

Conclusion

In Section 2 I explained the research methodology and data collection and analysis used in this study. A basic qualitative approach with interviews was used to answer the research question. I based my project to address the problem on the two themes that emerged from the data and the study's outcomes. The project, a white paper, will be described in detail and supported by literature.

Section 3: The Project

The purpose of this basic qualitative study was to explore five upper elementary educators' perspectives of science instruction to improve achievement in Title I elementary schools in a southeastern state. The findings of this study were used to write a white paper targeted for elementary teachers of science and their administrators. The results of this study indicate three components that address gaps in teachers' practice in science education and assessment. The three components are the basis for the recommendations in the white paper to support upper elementary teachers and their administrators. Section 3 includes a rationale for using a white paper, a literature review as it relates to the recommendations, a description of the project, the project evaluation plan, and a discussion of the possible social change implications of the project.

Rationale

I chose a white paper to communicate the recommendations from the study to teachers, their administrators, and district leaders. The components of the white paper include the problem this qualitative study addressed, the three recommendations, and the potential benefits of the recommendations. The three components are incorporating content area reading strategies that feature comprehension and vocabulary, STEM learning in elementary science classes to develop science learners, which might lead them to careers in STEM, and the use of assessment literacy to provide an in-depth understanding of student performance.

While developing this white paper, I included information about the local problem, a summary of the findings, visuals that support the content, and three recommendations based on the findings. The white paper will address the gaps in practice based on the findings of the study.

Review of the Literature

I conducted a scholarly literature review on white papers and topics related to my research outcomes. In addition to Google Scholar, I used Academic Search Complete, ERIC, eBook Collection (EBSCOhost), Education Source, Primary Source, and Teacher Reference Center databases through the Walden Library. The following search terms were used: *white paper in science, policy paper in science, position paper in science, content area reading strategies, STEM learning, STEM in elementary education, STEM in elementary science, literacy assessment,* and *assessing student performance.* Another search technique that was used was cite chaining older articles by using the "cited by" function in Google Scholar. I divided the literature review into discussions on white papers, content area reading strategies, STEM learning elementary science classes, and literacy assessment for understanding student performance in science.

White Papers

White papers are used by researchers to present a problem and a solution, communicate policy, or present data on a specific topic (Hyde, n.d.; UAGC Writing Center, 2023). They were initially used for government reports, but over time white papers have changed to include various formats across multiple fields of discipline (Anderson, 2022). The white paper should also include graphs, tables, and infographics directly related to its topic that supplement the content (Anderson, 2022; UAGC Writing Center, 2023). Lastly, white papers should start with the problem, provide an in-depth presentation and analysis of information, and end with a proposal or solution (Anderson, 2022; Dodge, n.d; UAGC Writing Center, 2023).

Several white papers have been published outlining principles for effective learning in elementary science (Carolina Biological, 2023; National Inventors Hall of Fame, 2023; Montgomery, 2022; NSTA, 2018; Taylor, 2021; Taylor, 2023). These white papers are examples of how white papers can be used to expound on elementary science education. Each white paper includes the necessary components for a quality paper as outlined by Anderson (2022).

Vocabulary and Comprehension Content Area Reading Strategies

Content area reading strategies are vital for student success across all academic subject areas. Teaching students content area reading strategies equip students with the tools they need to comprehend texts in various subjects including science. Understanding science content requires both vocabulary and comprehension strategies (Miller et al., 2021) empowers students to become confident learners who understand science content. First, I will explore three vocabulary strategies that can be used in the science classroom to enhance students' comprehension and retention of new information: read alouds, four square, and context clues. Following that, I will discuss three comprehension strategies that elementary science teachers can use in their instruction to enhance their teaching practices around reading comprehension: KWL charts, making inferences, and understanding text structure. By integrating these strategies, teachers can create a learning environment that supports the development of critical thinking and fosters a deeper understanding of science. The literature will provide an overview of these strategies and their applications in the elementary science classroom.

Vocabulary Strategies

Effective vocabulary strategies are crucial for improving reading comprehension and overall academic success. Vocabulary knowledge is important for students when reading and engaging in discussions (Baker & Santoro, 2023; Roessingh, 2020; Wright et al., 2022; Zelaya, 2022). Vocabulary strategies that science teachers can use to develop and enhance vocabulary knowledge for students are read-alouds, four square graphic organizers, and context clues.

Read-Alouds. Incorporating read-alouds in science instruction can build and increase students' vocabulary knowledge. Improving students' vocabulary knowledge can help address the gap in practice in science education. While reading science textbooks or other science materials to students, teachers can incorporate a vocabulary strategy to help students grasp and understand content area vocabulary. For example, Roessingh (2020) incorporated a read-aloud practice that can be used in the elementary classroom to build academic vocabulary. During and after reading, students experience new vocabulary words by completing learning tasks. These tasks allow students to see, hear, read, and write the vocabulary words to ensure they comprehend and know how to use the new words. While reading students can record words and definitions on flashcards or create a word web where the title of the text being read is recorded in a circle in the center of the paper with definitions from the text recorded in other circles surrounding the center circle. Transforming vocabulary words to a written mode helps students develop deeper learning and make meaning of science vocabulary words.

Four-Square. The Four-Square graphic organizer aids in reinforcing word meanings using visual aids. This visual aid can be beneficial when integrated into science lessons. The Four-Square graphic organizer allows students to actively construct their knowledge by connecting new vocabulary to their prior understanding and experiences (Cockrum & Markel, 2007). As students learn new scientific terms, they can take a blank sheet of paper and fold it in fourths. Students will then write the vocabulary word in one square and its definition in another square. Then, the teacher asks students questions that help them recall any experiences they may have had surrounding the new word. They use another square to record their experience with the new word. Next, students write a non-example of the word in the last square (Cockrum & Markel, 2007). Science teachers can use this strategy to ensure students comprehend academic vocabulary and know how to use it outside of the context in which it was used. This hands-on learning method could help students learn important science-based vocabulary.

Context Clues. Using context clues to infer meanings is an explicit and effective vocabulary instructional strategy that can improve students' skills in deriving word meanings (Bauer & Tang, 2022; Daugaard et al., 2020; Ilter, 2022). Bauer and Tang (2022) evaluated using context clues as an explicit vocabulary instructional strategy on 25 fifth-grade students at an urban Title I elementary school in the southeastern United States. The study findings showed that explicit instruction of using context clues (definitions of surrounding words, restate terms, examples, antonyms, synonyms, or explanations) to understand vocabulary positively affected students' vocabulary knowledge. Elementary science teachers can incorporate this content area reading strategy in their instruction to help students further develop their understanding of scientific vocabulary by teaching them specific strategies that will help them use context clues to understand unfamiliar words that they may encounter during science instruction.

Reading Comprehension Strategies

Reading comprehension is essential for learning. In addition to comprehending what they read, students should also know how to construct the meaning of what they read even if it is not explicitly stated (Bauer & Hengtao, 2022; Freed & Cain, 2021; Rice & Wijekumar, 2024). Three reading comprehension strategies that can help foster students' comprehension of scientific concepts are KWL charts, making inferences, and understanding text structure.

KWL Chart. As scientific concepts are introduced, students may already have background knowledge of those concepts. Elementary teachers could provide students with the space to share what they already know to build on and add to their prior knowledge. Implementing a KWL (what I know, what I want to know, and what I learned) chart during instruction is a strategy that could help teachers with activating background knowledge. Sayar and Anilan (2021) researched the KWL strategy in an elementary school during the second semester with fourth grade students. This study supports the effectiveness of implementing the KWL strategy during instruction and how teachers can use these strategies to improve reading comprehension. The students who used the KWL strategy had a higher reading comprehension score than the students who did not use the KWL strategy. Students found the KWL strategy instructive and useful.

Making Inferences. When science teachers understand the benefits of using content area reading strategies to help students comprehend what they read, they may be inclined to include such strategies in their instruction to address gaps in practice in science. Rice and Wijekumar (2024) examined several studies investigating the effectiveness of making inferences on reading comprehension. Inference instruction was shown to have positive effects on reading comprehension in the studies regardless of student age, reading ability, instruction, or the type of instructional text used. Inference instruction in science classrooms could have a positive impact on student comprehension.

Text Structure. Understanding text structure is vital for students' comprehension of scientific texts. Often scientific texts are organized using cause and effect, description, problem and solution, or other structures. If students can recognize the type of text structure, they are reading it can help them better understand and remember key scientific concepts (Miller, 2020; Miller et al., 2021; Wijekumar et al., 2020). Wijekumar et al. (2020) examined the effects of understanding text structures on reading comprehension. Fourth and fifth-grade students received instruction on using text structures to improve their reading comprehension. The findings showed that understanding text structures positively impacted student's reading comprehension skills. If elementary science educators understand the benefits of using research-based strategies like understanding text structure efficiently and effectively they may see an increase in student academic performance.

STEM Learning in Elementary Science

By incorporating STEM education into science classrooms, teachers can establish a relationship between the disciplines of science, technology, engineering, and mathematics. When teachers incorporate STEM activities, they provide students with opportunities to become problem solvers and critical thinkers (Diep et al., 2023; Gull et al., 2022; Hall-Dadson & Fraser, 2023; Roberts, 2020; Seage & Türegün, 2019). Parlakay and Koc (2020) used 64 fifth grade students to measure the effectiveness of STEM-based activities and tasks on student academic success and motivation. The researchers used an achievement test to measure student academic success and a science learning motivation scale to measure student motivation toward science learning. The STEM applications showed that students learned better and increased academic achievement when they were engaged in the STEM-based activities and tasks including hands-on experiments, various videos, class discussions, and interactive board games. Also, the STEM-based activities had a positive effect on student motivation toward science. The students' showed an increase in academic achievement after engaging in the STEM activities as measured by the achievement post-test. Parlakay and Koc (2020) pointed out that STEM activities can be used to address the achievement gap in science and increase student academic achievement by being used in elementary science classes.

Science teachers can use the results of Parlakay and Koc (2020) when incorporating STEM activities in the classroom. Teachers can make choices about the tasks that they can use for the introduction and exploration of science units. Including more STEM-based science practice may develop and improve critical thinking, creativity, and collaborative skills in addition to student achievement and motivation.

Wilcox et al. (2021) conducted research on the structure STEM lessons and concluded that STEM lessons should start with an exploratory activity that includes open-ended questions and discussions that will increase student interest and model what scientists, engineers, and mathematicians do. When creating STEM lessons, educators should teach students who scientists, engineers, and mathematicians are and what they do using readings, discussions, and videos. In addition, educators should teach STEM ideas multiple times and in multiple contexts. Students should also have opportunities to collaborate, be creative, make models, and participate in a variety of STEM activities.

STEM activities should include research-based best practices in the disciplines that are meaningful and relevant to students. Teachers should also be provided with professional development to support proper implementation (Cook et al., 2020; Wilcox et al., 2021). A 2-year case study of 25 teachers' professional development experience with STEAM (Science, Technology, Engineering, Arts, and Mathematics) planning and instruction. The 130-hour professional development focused on two research-based models: problem-based inquiry and interdisciplinary learning. Specifically, teachers were given models and instruction in problem-based learning, learned how to effectively co-teachers with other teachers and community partners, and used Plan-Do-Study-Act (PDSA) cycles for planning, implementation, reflection, and improvement on their STEAM lessons. The case study indicated teachers used more targeted standards to develop the inquiry-based lessons and created more engaging lessons and tasks that addressed the mathematical and science standards. The study also showed an increased implementation of science and engineering practices where students completed performance-based tasks and assessments and conducted scientific investigations and a focus on areas of instructional growth like using stories to inspire lessons (Cook et al., 2020).

Assessment Literacy to Understand Student Performance

Assessments provide educators with a wealth of information about the academic performance of students. Teachers' assessment literacy consists of understanding assessment concepts and procedures that will support classroom instruction, have a positive effect on instructional decisions, and improve student learning (Clark et al., 2022). Literacy assessments play a vital role in understanding student performance and identifying areas of improvement. Teachers and administrators should understand that assessments are more than testing and test scores. Learning about assessments that are aligned to student learning goals, the features and purposes of a variety of test formats, using assessment data to guide individualized instruction to meet the academic needs of students, improving teachers' understanding of students' areas of strength and areas of improvement, providing purposeful feedback to students, school personnel and parents, and ensuring assessment practices are valid and reliable would benefit teachers and administrators (Clark et al., 2022; Gatlin-Nash et al., 2021; Xu & Brown, 2016). Building teachers' assessment literacy knowledge can be done by purposeful professional development. Teachers need to know why they are assessing students and how the assessment methods (formative and summative) relate to content and learning goals and a variety of assessment strategies. If teachers build their assessment literacy, they understand the purpose of and types of feedback, and how to communicate assessment results to students, parents, and administrators. Student involvement in assessment is also part of assessment literacy. Involving students in the assessment process, leads students to use self- and peer assessment (Xu & Brown, 2016). Once teachers have increased their assessment literacy, they are in a better position to use assessment results effectively and efficiently (Al-Akbari, 2023; Clark et al., 2022; Cui et al., 2023; Gatlin-Nash et al., 2021; Meijer et al., 2023).

Project Description

Needed Resources and Supports

The local school district offers synchronous and asynchronous professional development sessions throughout the school year focused on understanding science standards and utilizing the Full Option Science System (FOSS) kits to address standards. Under the district's current structure, the Curriculum and Instruction Department has district instructional specialists who focus on specific content subject areas and work with school-based instructional coaches and teachers to support instructional practices in schools. I elicited support from the science district instructional specialists on how to distribute the white paper in the study schools. Per district requirements to conduct research, the completed project will be submitted via email to the director of assessment and evaluation for the district.

The district instructional specialists for science would be the main point of contact because they work closely with school-based instructional coaches, teachers, and school principals. District instructional specialists help develop curriculum and resources aligned to state standards that positively impact student academic achievement. They also work with district professional development coordinators to provide educators with comprehensive, research-based professional support and experiences designed to improve student achievement. If a printed version of the white paper is requested there will be a small cost for preparing the document.

Potential Barriers and Solutions

A potential barrier may be finding the time frame and location that is most conducive to meeting with the Director of Curriculum and Instruction and the science district instructional specialists twice as well as meeting with the school-based instructional coaches, science teachers, and school leaders. Ideally, the initial meeting with the curriculum and instruction director and the district specialists will be before the start of the academic school since they work throughout the year. The meeting with the teachers, school-based coaches, and school leaders will be at the beginning of the academic school year. Teachers and school leaders are required to participate in professional development sessions upon returning for the new school year so it would be beneficial to hold the session during one of the district-wide professional development days. As a motivator, teachers and school leaders will be awarded professional development credit for their participation.

Proposal for Implementation and Timetable

The procedure for circulating the white paper in the district is to send a copy of the white paper that includes a summary of the findings to the director of curriculum and instruction for review. After the documents have been reviewed, I will coordinate a meeting with the Director of Curriculum and Instruction and the science district instructional specialists to come up with a plan for disseminating the white paper as well as addressing any comments or answering questions, if needed. I will share an implementation plan that will highlight distributing the white paper starting with elementary school-based instructional coaches and ending with science teachers in Grades 3-5. At the start of the academic school year, during district professional development days, I would meet with school-based instructional coaches, teachers, and school leaders. At the end of the school year, I will have another meeting with the Curriculum and Instruction Director and the science district instructional specialists to follow up on the implementation process.

Project Evaluation Plan

The findings and recommendations from the study will be communicated using a white paper that was shared with teachers, school leaders, and other stakeholders. The project will be formally evaluated using a Google Form, based on the evaluation plan guidelines of the school district. The school district requires all professional development sessions to be evaluated by participants using an anonymous Likert scale (one through five) and short answer question format (participants to share details on support they may need with implementation and suggestions for improvement). The results of the evaluation will be used to see if the recommendations are helpful and if teachers intend to implement them in their science instruction.

Project Implications

The study was designed to use the information gained from the participants about their experiences teaching science to improve achievement in Title I elementary schools. One theme was the use of contracted resources, collaborative planning, a variety of teaching methods, instructional materials, and technology tools during instruction to improve student achievement in science. The other theme was incorporating several assessment methods to monitor student progress toward achievement of science standards. The development of a white paper was used to address the problem of the three themes that emerged from the outcomes of the study.

The goal of the white paper is to achieve possible social change by addressing the gaps in practice to improve science education at the elementary level. Improving science education may benefit teachers' professional development regarding teaching science standards science instruction. Specifically, teaching students content area reading strategies can help improve their comprehension and strengthen their scientific vocabulary knowledge. Incorporating STEM-focused learning to help develop science learners and improve their assessment literacy can help teachers better understand how to use assessment to improve student performance. Student achievement and interest in science could also improve. Students will have a better understanding of their learning objectives and expectations. This could also cause students to want to pursue careers in science in the future.

In a broader sense, this white paper can have social change implications on a national scale by helping educators and other stakeholders identify and implement strategies in science that will more accurately help students increase their awareness and interest in science. It can also help district leaders and those who develop science curricula adequately plan a science program that will support teachers and students learning in Grades 3-5. This could help educators in Grades K-2 develop meaningful science lessons that, in turn, foster an interest in science for students at an earlier age. The implications are that students in Grades 3-5 may have improved achievement on the science standardized test, allowing schools to increase their state report card ranking for the domain that addresses science education. As a result, the information may be used by other school systems to address gaps in practice. In Section 4, I will reflect on my professional and personal growth during the development of this project and present the strengths and weaknesses of the project.

Section 4: Reflections and Conclusions

Effective elementary science teachers have access to and consistently implement resources and professional learning strategies that support science instruction. Teachers and administrators should work closely together to establish goals and expectations for science instruction in the elementary classroom. Using resources and research-based learning strategies in science instruction will help students have a better understanding of science concepts, make learning science more enjoyable for students, and foster critical thinking and problem-solving skills. If the recommendations in this white paper are implemented in science classrooms and used to support science teaching and learning, student achievement in science could improve which could also improve students' science experience and their attitude and interest in science.

Project Strengths and Limitations

A white paper was the project for my study and was based on two themes that emerged from data analysis in Section 2: (a) Elementary teachers used contracted resources, collaborative planning, a variety of teaching methods, instructional materials, and technology tools during instruction to improve student achievement in science, and (b) Elementary teachers incorporated several assessment methods to monitor student progress toward achievement of science standards. Three outcomes resulted from my interpretation of the findings and are as follows:

1. Content area reading strategies that feature comprehension, vocabulary, and text formats.
2. STEM learning in elementary science classes to develop science learners,

which might lead them to careers in STEM.

3. Literacy assessment provide in-depth understanding of student performance.

As mentioned in the outcomes of the findings, science teachers already used best practices recommended by district and school personnel. The white paper contains those practices but extends them with the recommendations based on the outcomes of the study. The inclusion of both current and recommended practices is a strength of this project. Ensuring that science teachers use content area reading strategies will assist both the teachers and students with teaching and learning science content. Science textbooks are written by experts in that field and require instruction specific for comprehending text and understanding vocabulary. Science teachers, who realize they are teachers of reading, understand the importance of teaching students how to read textbooks, the scientific vocabulary, and use of unique text formats. They know that science textbook authors do not know the audience who reads their texts; therefore, it is imperative that science teachers spend time in teaching content reading strategies, so students comprehend the texts read.

The second benefit starts with STEM learning. Recent research in STEM learning extends student knowledge beyond the classroom, involving technology, engineering, and mathematics (Cook et al., 2020; Parlakay & Koc, 2020; Wilcox et al., 2021). These three disciplines plus science are combined with the intent of having students solve real world problems in the classroom. STEM teachers engage student learning featuring critical and creative thinking, teamwork, and skills in overcoming challenges. Students who have STEM backgrounds in a K-12 setting are open to numerous opportunities in the workforce and further education.

The last benefit, literacy assessment for teachers and students, help students to understand their academic performance in science. K-20+ teachers assess student knowledge to make decisions regarding instructional practices (Xu & Brown, 20176). It is imperative that teachers be trained in assessment literacy to interpret assessment data in formal assessments and to understand assessment in student learning, especially teacher-crafted assessments.

Regarding limitations, it is always difficult to ascertain whether the interest in science education exists across all schools within a district; therefore, this project is limited by buy-in at the teacher and administrative levels. It is not my desire to recommend mandated trainings for content area reading instruction and assessment literacy, nor is it my desire to mandate STEM training, either. These recommendations could be realized at the grass roots level if science teachers are willing to voice their needs to local building and district administrators.

Recommendations for Alternative Approaches

The gap in practice that the study addressed is unknown what experiences elementary educators did to improve students' science achievement. The study's problem could have been researched from only science teachers' perspectives in the district. Knowing what strategies, activities, and varying methods used to determine students' science achievement could have resulted in further specificity in teachers' instructional and assessment methods. Increasing the sample size would have added further credibility to the findings.

Viewing the problem from building principals' and district personnel would have provided a different perspective. Knowing how these two groups view science achievement would give insight into the importance of science in the curriculum as well as the emphasis on science education. Without support from administration, teachers are limited in how they deliver science instruction, which, in turn, limits student performance.

Scholarship, Project Development and Evaluation, and Leadership and Change

I have gained numerous skills in scholarship during my doctoral journey. As a doctoral student studying in the education field, I learned that conducting research is a rigorous process that requires the ability to embrace the need for growth as a scholarly writer. This doctoral journey has increased my ability to think critically as a scholar. Incorporating current, scholarly, peer-reviewed articles into my study taught me how to reach saturation of the literature. I gained the skills needed to write a proposal, organize research, and conduct and analyze data. While in the data collection phase, I learned how to conduct interviews in a way that took researcher bias into account and ways to avoid it in the research. I have grown as a scholar because of researching, reading, and analyzing processes.

Project Development and Evaluation

While completing this project study, I learned how to use research findings to develop a white paper that addresses a problem. Not only did I gain the knowledge and skills needed to conduct research, but I also learned about how to present data in a way that meets the needs of teachers and students. Completing a white paper was a challenge that taught me how to become an even stronger writer by using the findings to make and support my recommendations.

After researching the use and format of white papers I learned that they are used to highlight a problem and include recommendations for solving the problem (Anderson, 2022; UAGC Writing Center, 2023). My project included the findings from my study and recommendations on how to address gaps in practice and strengthen elementary science teachers' science instruction. The white paper needed to include literature that supported the recommendations and solutions (Anderson, 2022). I learned how to focus the white paper on the importance of supporting the recommendations to promote effective learning in elementary science.

Leadership and Change

My doctoral journey has been rigorous, but it has caused me to become aware of my strengths as a person and as a professional. It has been a mixture of challenges and discouragement, but an exciting and rewarding process. Sometimes it was hard to see the light at the end of the tunnel and I often struggled to stay the course. I promised myself I would see this to the end. As an elementary educator, I am an advocate for improving elementary teacher knowledge to improve student experiences. For example, using assessments more effectively and incorporating more STEM learning activities are two practices that I have incorporated more consistently. I have become more aware of making intentional educational decisions because of the research I have conducted. I have volunteered to serve in multiple leadership roles at the school and district levels to use the skills that I have gained during my doctoral program.

As a scholar completing coursework and the project during my Walden EdD program, I learned how to think and problem-solve as a researcher. The knowledge that I gained from reading peer-reviewed articles and other literature has allowed me opportunities to participate in academic discussions with school and district leaders about science education. I have learned how better to serve my school as an educator and instructional leader. This process has helped me shift my thinking and allowed me to hone my data-analysis and problem-solving skills as a professional educator.

As an educational practitioner, developing this project was rewarding for me as I had the opportunity to sit with educators, listen to their experiences, and use that information to help support science education. The books and articles that I read while working on my project study helped me identify effective strategies to use as well as reflect on the instructional practices that I was implementing in content area instruction. I applied the knowledge I gained from the literature and shared it with other teachers. Taking time to reflect on and adjust my instructional methods during this process improved student learning.

While working on this project, I realized that the work I did as a researcher prepared me to develop a project that would be instrumental in helping teachers with science instruction and other content areas. I enjoyed doing work that would be used to support my teaching and having the chance to influence and support other teachers across the district. Researching recommendations to address the gaps in practice helped me create a white paper that may be useful for teachers and school administrators to make instructional decisions that help student achievement in science.

Reflection on Importance of the Work

This project study and project are important to me because I engaged in research that will not only positively affect teachers at the local level, but most importantly, will positively affect the experience that students have in their science instruction. The information in the white paper can be used by district-level leaders to address the gaps in practice to improve student achievement in science. The recommendations could be useful by the superintendent, the Office of Assessment and Evaluation, and the Office of Curriculum and Instruction understand how teachers and principals perceive student science achievement and how they can be supported in science instruction. This work is important in creating a strong science foundation that could encourage students to pursue careers in STEM.

Implications, Applications, and Directions for Future Research

The implication for positive social change is possible if science teachers use readings strategies and literacy assessment to improve student academic performance, thus, leading to potential postsecondary education and careers in science. Teachers who spend time implementing best practices and strategies will have better content knowledge that can be beneficial to enhancing their students' content knowledge. Teachers who use the recommendations in the white paper to improve their science instruction may begin to organize instructional content in a way that makes it meaningful, engaging, and relevant to students. The learning experiences that teachers provide for students can include activities and opportunities to make sure students understand what they are learning.

Elementary school teachers can use the information in the white paper as a reflection tool for their instructional practices. Regardless of school status (Title I or non-Title I), student demographics, or teacher years of experience, the recommendations can be used by teachers to improve their science instruction, and administrators to support teachers in that improvement. When teachers incorporate best practices with fidelity, they create an environment with clear expectations for students that support their learning. Teachers who are providing science instruction that addresses gaps in practice will provide students with relevant activities, support standards, and incorporate resources beyond the curriculum textbook. This approach to learning will help teachers maintain a classroom focused on positive interactions and student-centered learning.

This white paper can be used by school administrators to understand how to support science teachers' instructional practices. As teachers use intentional instructional practices in the science classroom, they may need additional support with implementation. Administrators, as instructional leaders, can support teachers in several ways with implementing the recommendations in this white paper. They can work with district personnel (district superintendent of literacy, the director of curriculum and instruction, and ELA and science district instructional specialists) to coordinate professional development sessions for teachers during district professional development days at the beginning of the school year, with follow up sessions during grade level meetings throughout the school year. At the beginning of the school year, administrators can ensure science teachers have necessary professional learning opportunities featuring content area reading strategies, STEM learning, assessment literacy for all staff. School personnel might benefit from follow up sessions throughout the school year, demonstration/observation science lessons featuring reading strategies and STEM approaches to learning. Collaborative planning sessions, involving science teachers and administrators, featuring lesson preparation and content assessment would benefit teachers and students as well as demonstrating accountability to administrators.

Administrators and teachers are aware of the importance of accountability but have narrowed accountability to testing, which is more than testing and test scores (Xu & Brown, 2016). Science teachers, and all subject teachers, would benefit learning about designing and using assessments that are aligned and appropriate for testing learning goals; using a variety of test formats, their features and purposes; providing beneficial, accurate, and clear feedback to students, school personnel, and parents; and guaranteeing that valid and reliable assessment practices are followed.

Based on the current research, I recommend studying STEM learning in elementary science classrooms. Specifically, using a mixed methods approach to investigate the effect of inquiry-based and hands-on learning experiences as well as problem-solving activities and collaborative projects on students' conceptual understanding of STEM concepts and how they contribute to student engagement and motivation in STEM learning. The quantitative portion of the student would investigate an experimental group that receives inquiry-based STEM instruction and a control group that receives traditional science instruction. The qualitative portion of the study would include observations and interviews. The purpose would be to explore students' experiences with problem-solving and collaborative during treatment and traditional instruction. Quantitative data from pre- and post-assessments would be used to compare instructional methods on student academic performance. An observation checklist would be used to record which skills students demonstrated and their frequency of use. Interview data would feature what participants did to solve problems and collaborate with peers. I would also recommend investigating the long-term effects of STEM learning on students' attitudes toward STEM. This could be a major contribution to the STEM education field in following elementary students through their educational career through high school completion. It would be interesting to know whether students select higher education or workforce careers in science, technology, engineering, or mathematics.

A second area for further research would be an investigation of educators' perspectives on elementary science assessment practices. Researchers could collect the needed data to explore the types of assessments used in addition to educators' beliefs about the assessment purposes and limitations. The findings from the data could be used to identify patterns in the types of assessments used by teachers and explain teachers' perspectives on assessment in elementary science education. Continuing research into teachers' assessment literacy promotes positive social change from using current assessment to using various assessments that align with students' learning goals.

Another recommendation for future research could include a quantitative study that tracks the effect of implementing content area reading strategies into science instruction on student's reading comprehension and vocabulary. After the initial baseline assessment is administered at the beginning of the study to students in Grades 3, 4, and 5, data would be collected from the district benchmark standardized assessments that are given twice during the study period followed by the state standardized assessment in the spring. Data would only be collected from the questions on the standardized benchmark assessments that measure comprehension and vocabulary. Future research in the effects of implementing content area reading strategies could lead to positive social change by integrating literacy instruction into the science curriculum, promoting access to high-quality science education, and empowering students to become literate critical thinkers.

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Appendix A: The Project

Elementary Science Education in Title I Schools: A White Paper

by

Sidonye Maria Coaxum

Recommendations centered on the gaps in practice in science education and assessments: (1) content area reading strategies, (2) STEM learning, and (3) assessment literacy to understand student performance.

Background Information

According to the National Science Board (2013), the future success of the United States economy, environment, and safety depends in large part on scientific and technological innovations in the areas of health, industry, military, and energy. The National Science Board argued that to achieve such innovations, it is essential that the United States greatly increase the number of graduates who are equipped with skills in science, technology, engineering, and mathematics (STEM). Currently, "America's schools are not producing the science excellence required" (U.S. Department of Education, n.d.).

The Nation's Report Card for 2015 showed that the nation's children enrolled in public schools achieved low scores in science. In f4th grade, 24% scored below basic, 38% scored basic, 37% scored proficient and only 1% scored advanced. In 8th grade 33% scored below basic, 34% scored basic, 31% scored proficient and 2% scored advanced. In 12th grade, 41% scored below basic, 38% scored basic, 19% scored proficient and 2% scored advanced. In all three grades, more than 50% of students scored basic or below basic in 2015. Also, the statistics show that science achievement scores decrease as students advance through the grades. The subgroup of students who achieved the lowest science scores in 2015 were students from low-income families as indicated by their participation in the National School Lunch Program.

As teachers attempt to improve science achievement, research is needed about elementary educators' experiences teaching science to improve achievement in Title I elementary schools in a Southeastern state. In this white paper, I outlined the current problem, study findings that emerged after data collection and analysis, and provided three recommendations to address the gaps in practice and the educational benefits of the recommendations.

Research Description

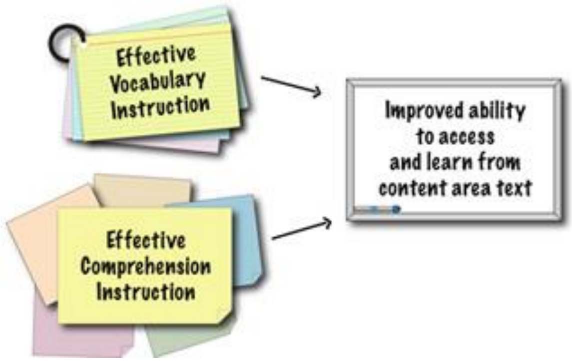
Five educators were interviewed to explore the elementary educators' experiences teaching science to improve achievement in Title I elementary schools in a Southeastern state. After collecting the data, the interviewees' responses were analyzed by finding patterns and developing themes. The study findings include three areas where gaps in practice in science education and assessment were identified, (a) content area reading strategies focused on comprehension, vocabulary, and text formats, (b) incorporating STEM learning in elementary science, and (c) assessment literacy that understands student performance.

The results of the data analysis indicated two themes that were the basis for the white paper. Elementary science teachers currently use best practices recommended by district and school administrators. The study's first theme included best practices including contracted resources, collaborative planning, various teaching methods, instructional materials, and technology tools during instruction to improve student science achievement. With the second theme elementary teachers incorporated several assessment methods to monitor student progress toward achievement of science standards.

Incorporating the recommendations by building on best practices gives elementary science teachers information that can be used to improve instruction and thereby could lead to increased student achievement in science.

Content Area Reading Strategies

For educators to address the recommendations of my study as well as the gaps in practice in science, they need to understand and implement two essential content area reading strategies: vocabulary instruction and reading comprehension. Teaching students content area reading strategies can help improve their comprehension and strengthen their scientific vocabulary knowledge.



Teaching vocabulary and comprehension strategies in elementary science helps students read to learn across subject areas and apply their prior knowledge when reading new material. As teachers incorporate vocabulary and comprehension strategies in their instruction, they are helping students develop critical thinking skills about what they are reading, develop content specific vocabulary, and understand and communicate on an advanced abstract level (Williams, 2023).

STEM Learning

By incorporating STEM learning into science classrooms teachers can establish a relationship between the disciplines of science, technology, engineering, and mathematics. Science, technology, engineering, and mathematics (STEM) learning programs provide students with opportunities to become problem solvers and critical thinkers (Diep et al., 2023; Gull et al., 2022; Hall-Dadson & Fraser, 2023). Research in STEM learning extends student knowledge beyond the classroom, involving technology, engineering, and mathematics (Babarović, 2022; Boz, 2023; Erkan & Durham, 2023). These three disciplines plus science are combined with the intent of having students solve real-world problems in the classroom. STEM teachers engage student learning by featuring critical and creative thinking, teamwork, and skills in overcoming challenges. Students who have STEM backgrounds in a K-12 setting are open to numerous opportunities in the workforce and further education.

Assessment Literacy

Teachers' knowledge and use of assessments depend on their assessment literacy, which is teachers' expertise and familiarity with assessments needed to evaluate and verify student learning (Dayal, 2021; Kula-Kartal, 2022; Wilkinson, 2024). Literacy assessment for teachers and students, helps students better understand their academic performance in science. Assessment literacy in the elementary science class can be used by teachers to ensure the science assessments align with students’ learning goals and science standards. Teachers can also provide students with feedback that focuses on student academic growth. This targeted and specific feedback can help students understand their strengths and needs. Assessment literacy can also be used by science teachers to identify areas of instructional support for students. These data can be then used to adjust science instruction to meet the individual needs of students. Xu and Brown (2016) realized that K-20+ teachers assess student knowledge to make decisions regarding instructional practices. Teachers must be trained in assessment literacy to interpret assessment data in formal assessments and to understand assessment in student learning, especially teacher-crafted assessments. Assessments created by teachers should be used specifically to ensure students are mastering science standards. Science teachers need to understand the importance and power of assessments on student performance and academic achievement.

Science Recommendations

Implementing the three recommendations that address gaps in practice can help elementary school science teachers further develop the quality of their science instruction. School principals can use the three recommendations to support science teachers in improving science instruction. School principals could also use these recommendations as instructional goals for teachers. Principals could also meet with teachers to collaborate, discuss their experiences, and share ideas as the teachers implement the recommendations.

Recommendation #1: Content Area Reading Strategies

The first recommendation is the implementation of content area reading strategies into elementary science teaching. Understanding science content requires a strong grasp of both vocabulary and comprehension strategies (Miller et al., 2021). Teaching content areas strategies for vocabulary and comprehension empowers students to become confident learners who understand science content.

Vocabulary must be learned to grasp scientific concepts. Employing vocabulary strategies such as read-alouds, where students can record science vocabulary words and definitions on index cards to transform vocabulary words into written words to help students develop deeper learning and meaning of science vocabulary (Roessingh, 2020). Additionally, a four-square graphic organizer helps reinforce word meanings for students by connecting new science vocabulary to prior experiences (Cockrum & Markel, 2007). Lastly, explicit instruction of specific strategies to help students use context clues to understand unfamiliar words can positively impact students’ vocabulary knowledge (Bauer & Tang, 2022).

Reading comprehension is more than understanding what is read. Comprehension strategies, such as incorporating a KWL (what you know, what you want to learn, and what you learned) chart in science instruction help teachers not only provide students with the opportunity to share what they already know about scientific topics but also let students build on and add to what they already know by documenting what they want to learn and what they learned at the end of the unit of study (Sayar & Anilan, 2021). Teaching students how to infer meanings of unknown words and coherence increases students' reading comprehension (Rice & Wijekumar, 2024). In addition, scientific texts are often organized using many types of text structures like cause and effect, and problem and solution. Teaching students to recognize and understand the different types of text structures can help them better understand what they are reading and improve their reading comprehension (Wijekumar et al., 2020).

Recommendation #2: STEM Learning in Elementary Science

The second recommendation is to include the integration of science, technology, engineering, and mathematics (STEM) to develop science learners. Parlakay and Koc (2020) studied the efficacy of STEM-based activities and tasks to enhance student academic success and motivation. Incorporating STEM-based activities and tasks in science instruction improved student learning and academic achievement. Students were highly motivated to learn science content when STEM was incorporated in the science curriculum and took learning beyond traditional science instruction. When students are engaged in scientific investigations, their problem-solving skills, higher-order thinking, and collaborative learning experiences are increased (Wilcox et al., 2021). STEM learning in the elementary science classroom might lead them to pursue careers in STEM.

> STEM lessons should include instruction that is research-based best practices in the disciplines that are meaningful and relevant to students as well as professional development support for educators to support proper implementation (Cook et al., 2020; Wilcox et al., 2021).

Recommendation #3: Assessment Literacy to Understand Student Performance

The final recommendation includes building teachers' assessment literacy. Assessment literacy is more than assessing standards, making instructional decisions, and gauging students' mastery of content. Teachers' knowledge and use of assessments depend on their assessment literacy, which is teachers' knowledge and experience with assessments needed to evaluate and verify student learning (Dayal, 2021; Kula-Kartal, 2022; Wilkinson, 2024).

Xu and Brown (2016) developed a framework for understanding teachers' assessment literacy. Their research resulted in six assessment components (knowledge base, teacher conceptions of assessment, institutional and socio-cultural contexts, teacher assessment literacy in practice, teacher learning, and teacher identity). Teachers' literacy assessment, as applied in science, would lead to a deeper knowledge of assessment and ongoing reflection of their assessment processes, and how to use assessment to enhance their instruction and student learning.

Educational Benefits of the Recommendations

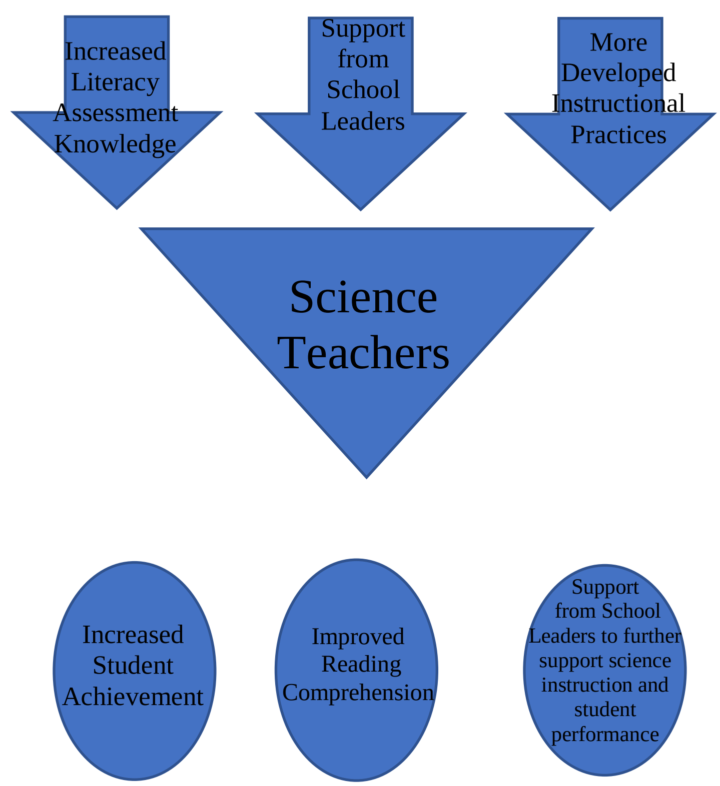
Using the recommendations from my study benefits students, teachers, and school leaders. Students will benefit from science teachers using the recommendations to develop their instructional strategies and assessment literacy. Using best practices will also increase student academic achievement (Xu & Brown, 2016).

Science teachers who integrate these three recommendations in their instruction may address the gaps in practice currently evident in the science classroom. As teachers are aware and address their gaps in practice, their instruction may raise students' higher order thinking levels to synthesize, evaluate, and apply what they learn in new situations. As teachers develop their teaching skills to include content area reading strategies, STEM learning, and assessment strategies, science content becomes more than facts to repeat on a test.

School leaders may increase their knowledge of reading strategies, STEM learning, and assessment literacy and can provide teachers with meaningful, ongoing professional development to enhance teaching performance and student outcomes.

Summary

The recommendations from this white paper are based on the research findings of my basic qualitative study. The recommendations include (a) content area reading strategies that feature comprehension, vocabulary, and text formats, (b) STEM learning in elementary science classes to develop science learners, and (c) assessment literacy to provide an in-depth understanding of student performance. Teachers who know about these recommendations and understand the importance of using best research-based practices can support students in improving their academic achievement in science. The benefits of incorporating these recommendations into elementary science classes may include an increase in student achievement, improved reading comprehension, and school leaders who can support teachers' science instruction and student performance.



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Appendix B: Interview Protocol

Research questions guiding the interview questions:

RQ1: What are the perceptions of grade 3-5 science teachers and principals at four high-performing and four low-performing Title I elementary schools regarding student science achievement, challenges they encountered when teaching science, and support and resources that teachers need to teach science?

RQ2: How do the perceptions of grade 3-5 science teachers and principals at four high-performing and four low-performing Title I elementary schools compare and contrast regarding student science achievement, teachers' science pedagogical practices, challenges encountered by teachers when teaching science, support and resources that teachers need to teach science?

Teacher Interview Questions:

1. (Schools 1, 2, 3, and 4) Low-Performing Schools From 2012-2013 to 2016-2017, more than 60% of students in Grades 3-5 at your school scored not met on the Science State Assessment (SCPASS). How would you explain student science achievement as measured by the SCPASS state assessment?

(Schools 5, 6, 7, and 8) High-Performing Schools From 2012-2013 to 2016-2017, fewer than 50% of students scored not met on the Science State Assessment (SCPASS). How would you explain student science achievement as measured by the SCPASS state assessment?

2. What are a few experiences that you have had while teaching science in your classroom?

3. About how much time in total do you spend on science instruction in a typical week?

4. How do you determine how much time you spend on science instruction?

5. When you teach science, about how often do you do a science demonstration? Implement technology into science instruction? Read to students from the science textbook?

6. How do you decide to so science demonstrations? Implement technology? Read to students from the science textbook?

7. About how often do your science students read a science textbook? Read a book or magazine about science? Discuss science in the news? Work with other students on a science activity or project? Give an oral science report? Prepare a written science report? Do hands-on activities or investigations in science? Talk about the measurements and results from students' hands-on activities? Take a science test or quiz?

8. How do you decide when to do these activities?

9. What challenges do you encounter when teaching science?

10. What resources and supports do you currently have access to in order to meet the needs of your students in science? Describe these resources and supports.

11. What resources and supports do you need in order to better meet the needs of your students in the area of science? Describe these resources and supports.

12. How do you feel about community support for science education?

Principal Interview Questions:

1. (Schools 1, 2, 3, and 4) Low-Performing Schools From 2012-2013 through 2016-2017, more than 60% of students in grades 3-5 at your school scored not met on the Science

State Assessment (SCPASS). How would you explain student science achievement as measured by the SCPASS state assessment?

1b. Why do you think so many students scored not met?

(Schools 5, 6, 7, and 8) High-Performing Schools From 2012-2013 through 2016-2017, fewer than 50% of students scored not met on the Science State Assessment (SCPASS). How would you explain student science achievement as measured by the SCPASS state assessment?

2. As an administrator, what are your perceptions of the effectiveness of science teaching at your school?

3. As an administrator, how do you support your teachers in the area of science?

4. How do you advocate for elementary science education?

5. How do principals build a support system for elementary school science by involving parents, educators, businesses, and other organizations?

Appendix C: Open Coding Table

Code	Transcript Excerpt	Participant Code
Technology tools for Instruction	Most of our tests to check their [students] understanding is done through Socrative.	T1
	…the content and the information and those are just short quizzes using Socrative.	T2
	We [teachers] actually use Flocabulary for that and they [Flocabulary] have a recap of current events that's going on in the world.	
	I think "It's Dr. Genius" is one that has a lot of good videos on there and Flocabulary as well.	T4
	We [teachers] wanted to have a few different stations where one of the groups was at the SmartBoard…	T3
	All of our students have iPads. Teachers have iPads. We [students and teachers] use our SmartBoard.	
	Day three I try to do the technology portion rather it's a BrainPop video, rather it's [technology implementation] something interactive on the SmartBoard for them [students] to play,	
	A lot of times we'll have Kahoot on the SmartBoard so that's being utilized.	T4
	Kahoot is an interactive game that we do on the SmartBoard.	
	Day three I try to do the technology portion rather it's a BrainPop video, rather it's [technology implementation] something interactive on the SmartBoard for them [students] to play,	T3
	We [teachers] have everything from Brain Pop. We have MyOn, where the children are able to go on [BrainPop and MyOn] accessed via student iPads].	
	The BrainPop app is good to pull up videos.	T4
	I use BrainPop. The students will go on their iPad and use a research-based website called PebbleGo.	T1
	There's more that I can use on the interactive whiteboard and also	T3

	that I can load onto their iPads for them to play. I found a lot of online resources that the children can play and build an online habitat on their iPad. All of our students have iPads. Teachers have iPads. What I will do for example, for online habitat building, I could load on their [students] iPad the resource that they [students] need. We [teachers] have everything from Brain Pop. We have MyOn, where the children are able to go on [BrainPop and MyOn] accessed via student iPads]. That's [incorporating technology] so important and being a 1:1 school with the iPad. Every child has access to an iPad at any point in the day. Sometimes they [students] have days [when] we use websites on the iPads, Kahoot is an interactive game that we do on the SmartBoard. The questions come on the screen and they pick the answer on their own individual iPad. Then we [students and teachers] use the technology portion, which is… It can be a video or the hands-on activity I like to show videos. We [teachers] have an intro video or some kind of hook just kind of get their [students] brains thinking in the right direction. I find things on YouTube all the time. Videos. I think "It's Dr. Genius" is one that has a lot of good videos on there and Flocabulary as well.	T4 T3 T4
Mastery of science content	What I usually have them [students] do is just screenshot what they've [students] done and that's how I will take an assessment. Formal [summative assessments]; I would say about once a unit. As for an informal [formative] assessment, I will take one; rather it's observing them [students] working with the material. I'll take one daily; just observing them [students] working with the material. I will assess [formative assessment] them after. We [teachers] do have them work with four-square writings organizers, and I will take that as an assessment in the room. They [instructional coaches and teachers] talk about how they're	T3

	going to assess those standards. They [instructional coaches and teachers] talk about making sure the assessments have higher level, lower level, middle level test questions on there to make sure kids have a true understanding of what they're [students] trying to learn. We do quizzes throughout [the science unit of instruction] to make sure the students are grasping the content. those are just short quizzes using Socrative. Throughout a unit and always at the end of a unit. [science test or quizzes] One test at the end and probably around 2 to 4 quizzes throughout. Most of our tests to check their [students] understanding is done through Socrative. Throughout a unit and always at the end of a unit. [science test or quizzes] One test at the end and probably around 2 to 4 quizzes throughout. We'll [students and teachers] do a class discussion of it [results from science activities] …of what they [students] found. When I have three to four students at a table with me and I'm asking them direct questions and we're having discussions	P1 T1 T2 T4 T1 T4 T3 T4
Teaching Methods	We've [teachers and students] also been doing different reports and projects We [teachers] like to implement those team based projects in the classroom. We [teachers] like to have to the students give an oral science report at least once per actual unit. If we give a research writing project the students will share those with the class…the information about what they learned on their topic. The only time that I will have them [students] prepare a written science report and moving into the end of the year I do think that they're [students] actually ready for that. We're [students and teachers] big on group work, team building, building those social skills; problem solving	T2 T3

	We [students and teachers] usually try to do group projects when they're at their centers.	T4
	There's at least one [center] where they're working with each other. Either they're [students] given a task and they [students] have to complete it or it's an interactive website where they [students] can share their creations or ideas. During our [students and teachers] science experiments, they [students] always work together on something.	
	True learning in science comes from hands-on and just doing it	P1
	We [teachers] really use the science kits that we've been provided and those have a lot of hands on materials.	T2
	We [teachers] like to do a hands-on introduction first,	
	[hands-on activities] Periodically through the unit with different manipulatives.	
	hopefully will try and get something hands-on once a week with the students.	
	Rather it [hands-on activities] be with technology and the use of interactive smart board, or going to the back of the room and doing a lab that's hands on there	T3
	We [teachers] try to do something [science demonstration] at least every week for the children to get their hands on.	
	like I said, we try to get to a hands-on lab towards the end of the week.	
	Within one unit, I would say about two [hands-on activities] in a unit. About two hands-on [activities] in this classroom. I know that sounds like very little in a four- to five-week unit, but they're [hands-on activities] long. They're [hands-on activities] extensive so when we do have those moments of labs, they [hands-on activities] take a few days. We'll [students and teachers] have to come back to them.	
	They're still doing activities; hands-on stuff.	
	We're [students and teachers] going to do some hands-on things where they [students] get up and display pollination. We [students and teachers] go outside and we [students and teachers] do things. When we [students and teachers] did weather tools, we [students and teachers] went out. They [students] actually got to use the weather tools outside.	T4
	They [students] also have different writing assignments that are a	

	little bit shorter than a paper. If we give a research writing project the students will share those with the class The only time that I will have them [students] prepare a written science report and moving into the end of the year I do think that they're [students] actually ready for that. When it comes to them being guided through the process of making those written observations and reporting them back to me. I will use their [students] writing samples from MadLab. If they [students] have to write a report or TDA [text dependent analysis] on something with animals, they [students] can get right on MyOn and look all of those science books up for them [students]. They [students] were reporting observations for 25 minutes yesterday; up until they [students] were walking out the door. As for an informal [formative] assessment, I will take one; rather it's observing them [students] working with the material. I'll take one daily; just observing them [students] working with the material. I will assess [formative assessment] them after. They [instructional coaches] go in and do observations in the classroom. put together the lessons that worked and the experiments that worked for our students, which helps us [teachers] better teach the science standards. It [science kits] gives us different experiments and examples for students, They [contracted science lab instructors] have different science based experiments that they [contracted science lab instructors] do. we [teachers] use it [contracted science lab experiments] as one of the experiments we're [students and teachers] going to learn. The experiments usually come at the end of the unit or after the whole group instruction is given. The FOSS science kits that from the district have a lot of activities that are aligned directly from the standards. They [FOSS kits] come with the teacher's manual and also usually student workbooks or student reading material. All the materials that we [students and teachers] would need in order to perform those experiments. We [students and teachers] use those usually at the end of the unit whenever we're doing our hands-on experiment type things.	T2 T3 T3 P1 T2

	During our [students and teachers] science experiments, they [students] always work together on something.	T4
	They've [High-Tech High Touch] come in and they do science experiments with our kids every other week.	
	We [students and teachers] try to do it [science demonstrations] near the end of the unit.	
	We [teachers] try to do it [science demonstrations] at the end of the unit, but we [teachers] are going to go back and do some more [science demonstrations] near the end of the year now that we've [students and teachers] gotten through the content.	
	If we [teachers] have a lab that requires students to rotate in groups just due to lack of time during the class, at times, students will be asked to visit different stations	
	Yes I can, for example, we [teachers] had one afternoon that we wanted to do something really engaging with the students. We [teachers] wanted to have different stations.	
	We [teachers] wanted to have a few different stations where one of the groups was at the SmartBoard and one of the groups was putting together some circuits to make a lightbulb light up.	
	What we [students and teachers] started doing around the end of the second quarter is science centers in the room. I have about four to five centers in the classroom. We [students and teachers] do a variety of activities where they [students] rotate throughout the centers. That [science centers] has improved their test scores as well as just the general behavior and the way that they [students] feel about science. They're [students] not dreading it. They [students] look forward to it. Whenever I say we're doing centers, they [students] get excited.	T3
	Before the science centers, I wanna say we [students and teachers] took about three or four weeks to get through the content. Once we started doing science centers, it only took about maybe two weeks.	
	So that [science centers] has shortened the time we've had to spend on a unit as well.	
	We [students and teachers] usually try to do group projects when they're at their centers So far, switching to the science centers has helped a lot for me to see where they are. Helping them to get engaged but also to see if they're retaining the information or not	T4
	I personally will just model something for the students.	
	They [instructional coaches] do model lessons in the classroom.	

		T3 P1
Science Units of Instruction	We [teachers] base it [discussion] off of their schema…remember when we [students and teachers] were in the science unit [science lab unit of study] and we [students and teachers] did extreme weather. When we [students and teachers] did weather tools, we [students and teachers] went out. They [students] actually got to use the weather tools outside.	T2 T4
Collaborative Planning	We [teachers] do team planning and we [teachers] bounce ideas off each other for different resources for students. We [teachers] also plan one day with the fourth grade team of teachers. We [teachers] make sure that we're [teachers] on the same page. We [teachers] discuss things that we're [teachers] struggling with and how we can fix what we're struggling [with] so the lessons flow more smoothly. They [instructional coaches] meet with teachers weekly and they [instructional coaches] also join the grade level planning meetings each week We [teachers] have a PLC meeting at least once a week where we [teachers and admin staff] talk about different curriculum and goals. spoke recently in one of our TCT meetings about how our test prep is taking up, being the testing season, how it's taking up a longer amount of time throughout our [teachers] day. I'm just…I'm having a little bit of trouble fitting it [science instruction] in.	T2 P1 T2 T3
Contracted Resources	talking to our MadLab Science, the High Tech High Touch [instructor] and correlating something with our standards there They [High Tech High Touch] come to our school and they [High Tech High Touch] do a lesson. It's usually one person comes, and she sets up the lab with help from some of our staff.	T3 T4
Instructional Materials	We [teachers] really use the science kits that we've been provided and those have a lot of hands on materials. a few years ago, we [teachers] were learning the science kits. Once we [teachers] got a feel for the science kits we [teachers] were able to put together the lessons that worked and the experiments that worked for our students, which helps us [teachers] better teach the science standards. It's [science kits] based off each of standard that we teach. It gives us different experiments and examples for students, The science kits we [teachers] get delivered from the district. They [science kits] go along with the different units that we [teachers]	T2

	teach in science.	
	I do find that we have been given these amazing FOSS kits from the district, from the county;	
	They're [FOSS kits] great resources; they [FOSS kits] absolutely are.	T3
	The FOSS science kits that from the district have a lot of activities that are aligned directly from the standards. They [FOSS kits] come with the teacher's manual and also usually student workbooks or student reading material.	T4
	They've [FOSS kits] been kind of more interactive and more enjoyable for the kids	
	What comes in those kits [FOSS science kits] are different manipulatives the students can use.	
	Then we'll [teachers] teach aspects [of the science unit/standards] using different manipulatives in the class.	T2
	They [students] had different sound tools in this unit. They [students] did get to manipulate the different science tools and experience the wavelengths and the sounds with different tools from that [science] kit.	
	When we [students and teachers] did weather tools, we [students and teachers] went out. They [students] actually got to use the weather tools outside.	
	and then we [teachers] also have our student science books, and other curriculum resources that we use to help us [teachers] guide and teach the science standards.	T4
	We [teachers] have a good selection of science textbooks in our library that we pull from as well.	T2
	We [teachers] also have the CCSD curriculum online that we [teachers] look for activities for.	
	they [students] can get right on MyOn and look all of those science books up for them [students].	
	The science textbook, Interactive Science; it's chunk down [break down science information] very well. It gives the children exactly the information what they need	T3
	We [teachers] are given our science curriculum.	
	Occasionally, I'll have them [students] pull it [science textbook] out if we [students and teachers] do have whole group instruction	

	We [students and teachers] have our science textbook. We [teachers] find different articles as well based on the topic to help our students understanding as well.	T4
	We [teachers] do use a TIME Magazine. When it does relate to science we will pull that into our science time so that they [students] can get the experience with an actual magazine and the different articles in there. So with the TIME articles that does have to do with current events so when we [teachers] see those we'll do it.	T2
	We [students and teachers] are still deeply involved in our animal studies magazine right now. They're [animal studies magazine] quick [a minimal amount of instructional time needed to complete], they're [animal studies magazine] pretty short, usually about a week out of the unit, they'll [students] work with their [students] text to world connections in their [students] magazines.	T3
	We [teachers] have some TIME magazines that we've [teachers] been getting at school. When they [students] finish a test early or something, they [students] can go and get one of those magazines. They're [magazines] always there on the shelf for them to have access to after they're [students] finished with the test. Sometimes during ELA we'll [teachers] say, "Hey go pick one of those [magazines] up", just to get them a little bit more kind of real-world science exposure. When they [students] get those [magazines], they [students] come over to me. "Hey, I found this in the magazine. This is from what we were learning directly." That's been kind of cool too, because, one, you know that they're [students] actually reading, and, two, they're [students] making those connections with the real world in science. Some of that is current.	T4