Departmentalized Classroom Environments Versus Traditional Classroom Environments for Elementary Science Instruction: A Qualitative Analysis

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Abstract

The purpose of this qualitative study was to investigate elementary teachers' perceptions concerning the professional development, training, and learning structures of science education. Through comparison of participant responses to interview questions, the researcher was able to compare the perceptions of elementary educators at a building that departmentalizes for instruction with educators that are at buildings that implement traditional classroom structures for science instruction. Three research questions guided the study: (1) What are teachers' perceptions of the effectiveness of science instruction in a self-contained or departmentalized structure? (2) What are teachers' perceptions of the levels of training provided for science teaching in self-contained versus departmentalized structures? (3) What are teachers' perceptions of science teaching during the COVID-19 challenges in schools? Results include three findings. The first finding was that teachers in both organizational structures do not believe that professional development prepares them for teaching science, and that they gain the most from collaboration with colleagues. The second finding addresses the perception that teachers that implement the integrated approach feel that science education is not treated with the same respect that mathematics and literacy standards are given. Science standards are often integrated into literacy lessons, so that the topics can be addressed during ELA core. Hands-on activities, experiments, and projects that are specific to science are not a priority focus due to the district priority for reading proficiency. The third finding was that mandatory remote learning pushed science instruction even further down the list of priorities. Findings compare favorably with literature reviewed that suggests teachers must be

trained to feel competent. Future research may be helpful to find ways for science education to become prioritized through a change in organizational structures.

Dedication

First, I would like to give all honor and praise to God, my Father, because without His blessings, grace, mercy, and strength I never would have had the desire or determination to complete this journey. Thank you, heavenly Father for holding my hand through difficult times and picking me up and carrying me when I felt like I wanted to give up. If someone would have told me three years ago that I would one day be a doctoral student, I would have laughed until my cheeks ached. God knew my purpose, so I was obedient to His word. "For I know the plans that I have for you, declares the Lord, plans to prosper you and not to harm you, plans to give you hope and a future," (Jeremiah 29:11, New King James Version).

I dedicate this work to my mother, Arnita Coleman-Spencer, who lost her battle with colon cancer on February 2, 2007. Before my mother passed away, she said to me, "Myesha, you never had to be a college graduate, doctor, or rocket scientist for me to tell you that I am proud of the woman that you have become." Well, mommy, I can honestly say that I am both a college graduate and hold a doctoral degree, and I know I owe my interest in and love of education to you. You instilled a love of learning in me from the very first Dr. Suess books that you got for me, and I have not stopped learning and craving more information ever since. My only regret is that I waited later in life to aggressively pursue my career, so you never got the chance to witness my success firsthand, but I know you would be my biggest cheerleader.

"There are only two lasting bequests we can hope to give our children. One of these is roots, the other, wings" (Carter, H. 2014). I want to thank my children, Serenity, Sincere, and Surreal, as well as my granddaughter Noelani Dior, for understanding why I

took so much time away from you to pursue my career. Surreal once said, “all you do is read and type, read and type.” And he was right. I felt terrible, but all I could offer was an apology and a promise that once this is completed, I will dedicate my free time to doing my best to make up for the time I was unable to go places with you, cook your dinner, or even just watch television with you. This next chapter of my life is called, Family First.

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as crazy and ambitious as pursuing a doctorate together. I know I would have quit every week without being able to vent and work collaboratively with you throughout the duration of the program. Mike Russell, you are one of the smartest and most intelligent people I know. I appreciate your insight and assistant after our coursework, you always stayed one step ahead of me, and gave honest and thorough advice for how to make it through each step that was right in front of me. I am so proud of your new career change and am honored to say I knew you before the millions start rolling in. Stacy, thank you for our in-person trip to the Baker University campus and agreeing with me when we ran from our hotel together. April Bullman, your staying in touch with me and sharing your personal experiences with each step was a gift. I appreciate you sharing the story of our similar struggle for leadership positions and I am praying that we both land the position that God has blessed us with.

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Chapter 1

Introduction

"I only teach science when I can fit it in" is a statement that is commonly spoken by elementary classroom teachers. The No Child Left Behind (NCLB) Act put tremendous pressure on administrators and teachers to raise the mathematics and English Language Arts (ELA) state assessment scores of all students. With the primary focus of the law being mathematics and ELA, other core subjects (i.e., science and social studies) were not given the attention and explicit instruction practices with fidelity (Klein, 2015). The publication of *A Framework for K–12 Science Education* (National Academies of Science, 2012) included a new vision for science education and endorses significant conceptual modifications in science instruction. The National Science Teaching Association (NSTA, 2021) supports this new vision—and its application in the Next Generation Science Standards (NGSS)—and has recommended all educators transition to three-dimensional teaching and learning. Students are held accountable for meeting state and national assessment standards for science and social studies. However, governmental guidelines and tests often focus on middle and high school-level in science, technology, engineering, and math (STEM) fields (Academic Partnerships, 2017).

As children grow in an increasingly technologically and scientifically advanced world, they need to be scientifically literate to succeed. Ideally, teaching the scientific method to students teaches them how to think, learn, solve problems, and make informed decisions (Academic Partnerships, 2017). Researchers at the University of Texas in Arlington (2021) have suggested that:

> Science education is an imperative core subject attributable to its application to students' lives, commonly applicable problem-solving and critical thinking skills it teaches, uses and develops. Skills that students obtain and develop during science instruction can be applied to their higher education and careers because students practice generating ideas, decision-making, finding evidence to support a claim. Science and technological skills are developed and enhanced during critical thinking, problem solving, and inquiry lessons and activities which will impact their success in secondary education and higher education. (para. 11)

NSTA (2021) identified the significance of effective elementary science education and recommended the engrossment of all education stakeholders to deliver effective and equitable instruction, materials, environment, structure, and opportunities so that all students may increase their performance. NSTA also recommended:

> There must be adequate time in every school day to engage elementary students in high-quality science instruction that actively involves them in the processes of science. NSTA does not find a research basis for recommending a specific number of minutes for teaching core content, including science. However, most states, districts, and schools currently prescribe a set number of minutes—either by day, week, or year. (para. 8)

As a result of this practice, science receives far less instruction time than other core subjects (Horizon Research, 2013). NSTA recommends that science be given equal priority as other core subjects, so schools should strive for at least 60 minutes of science instruction a day, including significant science investigations (2021). NSTA also suggested that one of the fundamental principles to guide effective science instruction is the elementary structure for teaching science.

Science education has traditionally received insufficient attention. Teacher preparation in science will be best served by improvements in pedagogy and content of required undergraduate science courses. The American Association for the Advancement of Science (1993, 1995) and Banilower, Cohen, Pasley, and Weiss (2010) have addressed this need in advocating a “science for all” that is highly significant for diverse learners. The No Child Left Behind Act emphasized that reform of teacher preparation is part of an urgent national responsibility to bring high-quality teacher candidates into classrooms (Mangrubang, 2004).

Background

The Elementary and Secondary Education Act (ESEA) was signed into law in 1965 by President Lyndon Baines Johnson, who proposed that educational opportunity at its fullest should be America’s highest national goal (U.S. Department of Education, 2019). ESEA offered new grants to districts serving low-income students, federal grants for textbooks and library books, funding for special education centers, and scholarships for low-income college students (U.S. Department of Education, 2019). Additionally, the law provided federal grants to state educational agencies to improve the quality of elementary and secondary education (U.S. Department of Education, 2019).

The focus of ESEA was to respond to educators’ and administrators’ call to attention concerning the No Child Left Behind Act of 2002 and the demands it put on teachers and administrators to ensure that all students were making progress and determine in what academic areas each student needed additional support regardless of race, income, zip code, disability, home language, or background. The law was scheduled for revision in 2007. NCLB's prescriptive requirements became increasingly unworkable for educators. In 2010, the Obama administration joined a call from educators and families to create a better law that focused on the clear goal of fully preparing all students for success in college and careers by preparing all students for success in college and careers (U.S. Department of Education, 2019).

The current study was conducted in elementary school buildings in a Kansas district responsible for educating approximately 11% of all public-school students in Kansas and more than half of all school-aged children in the county (District X, 2021). During the 2020-2021 academic year, the district served 50,303 students, including 7,318 students receiving special education services, and 76.5% coming from homes of poverty (District X, 2021). There are 54 elementary schools in this district; however, data gathered for this study were collected from schools sharing similar demographics while implementing two different structures for teaching science (District X, 2021). Some building leaders choose to departmentalize core subjects to develop teaching specialists in elementary schools to address the lack of teacher professional development, subject knowledge, pedagogical skill, and time necessary to teach. Other building leaders implement an integrative approach to teaching elementary core subjects; science and social studies topics and standards are addressed through cross-curricular alignment of mathematics and ELA lessons.

Statement of the Problem

Students are responsible for meeting state science assessment standards; however, they are not exposed to the science curriculum with fidelity and consistency (Assistant superintendent of learning services, personal communication, August 9, 2021). One approach to remedying this issue implemented by other districts is to departmentalize elementary core subjects and structure professional development to advance teacher specialists for each subject (Goddard et al., 2007). The problem addressed by the current study to determine teacher perceptions of each educational setting, the traditional structure in which the classroom teacher delivers instructions or the departmentalized structure in which a science teacher specialist is responsible for delivering instruction, yields the most positive perceptions of science instruction and teacher professional development and training. The researcher was also interested in exploring the perceptions that teachers and educational leaders in the district held concerning Coronavirus pandemic’s impact on science education during the mandatory shutdown when lessons and activities were only available via Microsoft Teams, an online learning platform. The process of reopening schools required stringent restrictions for student movement, frequent sanitizing, facial masks, and social distancing practices that curtailed departmentalized models of education.

Purpose of the Study

The purpose of this study was to gain teacher perceptions of two instructional structures in science education. The study used a phenomenological qualitative methodology to collect and analyze teacher responses regarding their perceptions of the effectiveness of science instruction in self-contained or departmentalized structure. The second purpose was to determine teacher perceptions regarding teachers’ perceptions of the levels of training provided for science teaching in self-contained versus departmentalized structures. The third purpose was to determine teachers' perceptions of science teaching during the COVID-19 challenges.

Significance of the Study

Elementary teachers are expected to meet state and national demands for instructional time and student achievement for mathematics and ELA so they "borrow" instructional time from science and social studies blocks rather than utilize allotted time for science or social studies instruction even though students are also expected to meet proficiency on state assessments (Assistant superintendent of learning services, personal communication, August 9, 2021). Science is an underrepresented core subject in elementary schools due to the primary focus on increasing student proficiency in mathematics and ELA. Another issue that surfaced concerning the lack of science instruction in elementary schools was that teachers are not comfortable with their pedagogical knowledge and preparedness to deliver effective science instruction. Most elementary school teachers have little scientific background, and many say they feel unprepared to teach the subject well, according to a national survey of science and mathematics education conducted by a North Carolina research firm in 2012. Just 44% of K-2 teachers felt they were "well prepared" to teach science, according to the survey, compared to 86% who felt well prepared to teach reading (Mongeau, 2018).

One attempt at remedying the issue of teacher professional development, increase the amount of science instruction, and positively impact the teaching and learning of science is to departmentalize. Departmentalizing science allows elementary teachers to become an "expert teacher" in their chosen subject, making science instruction more purposefully planned. While there are reported advantages to departmentalization, it is unknown if departmentalization leads to a better performance in science. There has been a fair amount of research on the effects of departmentalization on elementary student achievement, but most of the results have been inconclusive. This study is needed to share deeper insights of teachers' perceptions regarding effects that departmentalization compared to the traditional integrated structure have on student achievement in science. Results may provide significant information to guide teachers and administrators to improve science instruction.

Delimitations

Delimitations utilized by the researcher were determined by the desire to gain a deeper insight and understanding of the similarities and differences in the teacher perceptions of structural teaching practices of elementary science. The study sample was delimited to elementary teachers who taught science in a departmentalized structure and those who taught science in a traditional self-contained structure. A second delimitation was that the sample of educators in the interviewing process were all employed by the same district during the 2020-2021 school year.

Assumptions

This section provides the reader with universal beliefs that are assumed to be true by a large part of society, even though they have not been scientifically tested, but are accepted as true based on logic or reason, but without truth or evidence by researchers and peers who will read this study. Those assumptions include:

1. The participants responded to interview questions by providing truthful depictions of teacher perspectives in a candid manner.
2. Participants have all experienced the same or similar preparation to teach science.
3. Participants had a sincere interest in participating in the research study, did not have any other motives, and did not expect any compensation.
4. Perceptual data gathered were accurate, current, and a true representation of student academic achievement and engagement.
5. Educators completed professional development and collaborative practices at the building and district levels.

Research Questions

The following research questions were used to guide this study:

RQ1. What are teachers' perceptions of the effectiveness of science instruction in self-contained or departmentalized structure?

RQ2. What are teachers' perceptions of the levels of training provided for science teaching in self-contained versus departmentalized structures?

RQ3. What are teachers' perceptions of science teaching during the COVID-19 challenges in schools?

Definition of Terms

The researcher has included a collection of educational terms that require defining for the reader to comprehend the educational jargon and components of the study.

Departmentalized model. Mulvahill (2016) stated that departmentalization is a cost-neutral way of upgrading instruction allowing elementary teachers to focus on and master one or two subjects for a greater level of expertise and deeper understanding. This structure allows teachers to have a greater ability to differentiate their instruction to meet the needs of all learners. Departmentalizing prepares students for the transition to middle and high school.

Generalist. Thompson (n.d.) indicated that generalist teachers, also known as the homeroom teacher, are most often found in elementary and middle schools, teach all basic subjects, often to more than one grade level. Generalist educators hold a general education degree that includes mathematics, literacy, science, and social studies in grades kindergarten through 6 in most states. A generalist is one whose skills, interests, or habits are varied or unspecialized, and, therefore, knows something about each of the core subjects.

Inquiry learning. Grade Power Learning (2018) indicated that inquiry instruction is an approach to learning that emphasizes the student's role in the learning process, rather than the teacher lecturing students about what they need to know. Students are encouraged to explore the learning material, ask questions, and share ideas collaboratively with their peers. Similar to experiential learning, inquiry-based learning actively engages students in the learning process beyond just the "sit and get" approach of reading text and answering comprehension questions. Instead, students are afforded the opportunity to explore a topic more deeply and learn from their own first-hand experiences.

Pedagogy. Longman's Dictionary (2021) defined pedagogy as a formal term for "the practice of teaching or the study of teaching" (para. 1).

Teaching specialist. Specialist teachers are primary and secondary teachers who have obtained expertise in a particular field or subject area through professional development, training, or higher education courses specific to their practice. Specialists include teachers hired for a specific subject such as mathematics, literacy, science, social studies, art, music, physical education, career advising, school counseling, teacher librarianship, and teaching English as a second language (New South Wales Department of Education, 2021).

Traditional classroom model. Most consider it traditional when a classroom structure requires the regular education classroom teacher to be responsible for instructing all core subjects (mathematics, literacy, science, social studies) for students assigned to their homeroom (Gutek, 2018).

Organization of the Study

Chapter 1 consists of an introduction to the study, background information on the history and role of science education in elementary school, professional development and training provided at the district and building levels, and a purpose for the study. Chapter 1 also includes the significance, assumptions, and delimitations of the study. Terms utilized throughout this study are defined in this chapter. The methodology is introduced along with the research questions. In Chapter 2, the literature review guides the reader through the history of science education, professional development practices within the United States, and defines structures for effectively teaching elementary science. Traditional classroom models, departmentalized models, and the various structures and roles for the inclusion of science teaching specialists are detailed in Chapter 2. Outlined in the chapter are trends, challenges, and outcomes of teacher professional development and training and impact on teacher and student outcomes. Chapter 2 concludes with literature surrounding the importance of effective and consistent elementary science instruction for foundational skills in secondary, post-graduation, and career readiness. Chapter 3 contains an explanation of the research design, methodology, and instrumentation. Chapter 3 begins with description of the research design, rationale, and paradigm for the overall study. The qualitative components include a description of participant selection, data collection procedures, qualitative data analysis, reliability and trustworthiness, researcher's role, and limitations. Chapter 4 provides detailed results of analysis of the data. Chapter 5 provides the study summary, findings related to the literature, recommendations for future research, and conclusions.

Chapter 2

Review of the Literature

An impactful educational truism is that teachers must know the content they are to teach (National Academies Press [NAP], 2007). While no teacher could effectively support student learning without first mastering the content of the curriculum, effective teaching requires more than simple mastery (NAP, 2007). “Quality instruction entails strategically designing student encounters with science that take place in real-time and over a period of months and years (e.g., learning progressions), teachers drawing on their knowledge of science, their students, and pedagogy to plan and enact instruction,” (NAP, 2007, p. 297). Thus, to be considered effective, teachers must be skilled and knowledgeable in understanding science content, learner strengths, weaknesses and interests, and pedagogy strategies and designs, and be able to monitor students’ science learning experiences, and how to utilize various assessments to gather data to guide their planning and teaching.

Chaney (1995) and Goldhaber and Brewer (1997, 2000) shared that research results broadly support the belief that higher levels of teacher subject matter knowledge are directly connected to higher student achievement (as cited in NAP, 2007). They also asserted that having a major or a graduate degree in a subject increases a teacher’s effectiveness and positively impacts student achievement (as cited in NAP, 2007). Monk found a positive relationship between the number of postsecondary mathematics and science courses taken by teachers and improvements in achievement results (NAP, 2007). Research supports this, even though there has been less investigation regarding the knowledge levels of elementary teachers (NAP, 2007).

According to Rowan, Correnti, and Miller (as cited in NAP, 2007), the preeminent level of subject matter training for a teacher is unclear, and there is some indication signifying a threshold effect—a point after which further course work delivers no additional measurable impact on student learning. Monk found that additional coursework was not associated with additional gains in student achievement once a teacher had completed four physical science courses (NAP, 2007). Rowan et al. and Hawkins et al. suggested that the impact on students might be different depending on the level of the grade being taught; the achievement of middle and high school students is more directly affected by a teacher's subject preparation to a greater extent than for elementary students.

Evidence from case studies of science teachers indicates that teacher preparation directly affects instructional strategies and classroom management, such as routines, procedures, and student behaviors. For example, Sanders, Borko and Lockard conducted an in-depth analysis of three science teachers teaching inside and outside their areas of certification (as cited in NAP, 2007). Sanders et al. (as cited in NAP, 2007) suggested that when teachers had limited knowledge of subject matter and pedagogical skills, teachers would struggle to ask meaningful questions that deepen student discussions and thinking, and they were also limited on the activities that they could prepare for student engagement.

Science understanding is also important in terms of quality, even more than the quantity of knowledge (NAP, 2007). If teachers expect students to reach science proficiency, they must achieve proficiency across the four strands, reading, writing, listening, and speaking (NAP, 2007). However, undergraduate science curricula, comparable to those in K-12 science, are susceptible to being biased toward conceptual and factual knowledge and reflect poor views of scientific practice (Trumbull & Kerr, 1993). Prospective teachers stereotypically view scientific practice in a similarly narrow light (Bell, Abd-El-Khalick, Lederman, McComas, & Matthews, 2001). For instance, in a study by Windschitl (2004), 14 pre-service teachers with earned bachelors' degrees in science were followed regarding their thinking about science and resulted in similar conclusions.

Experiential limitations in K-8 teachers' knowledge of science education are not startling given the mixed and commonly low expectations written in teacher certification policy at the state level (NAP, 2007). Little has changed in the intervening years. Although 80% of states required demonstration of subject matter competence and aptitude for completing an elementary school certificate, there is little common content among the states (NAP, 2007). Delaware, Maryland, and Maine required the highest number of credit while Hawaii and Kansas did not require any credit hours in science (NAP, 2007). Other states used tests to assess subject matter knowledge. For example, Arizona elementary school certified teachers must pass a subject knowledge assessment. Without examination of each state's assessment instrument, it is difficult to ascertain what proportion and to what extent any state assessment test covers science teaching and learning.

There is scant evidence concerning how elementary and middle-grade teachers are prepared in science. Few controlled analyses of how teacher knowledge and skill influence student achievement outcomes (NAP, 2007). Without knowledge of a correlation between teacher preparation and student outcomes, teachers must rely on credentialing standards to depict what base-level proficiency looked like in current practice (NAP, 2007). "Elementary teacher preparation accreditation standards provide a sense of the base-level expectations that certified programs hold for prospective elementary teachers' knowledge of science" (NAP, 2007, p. 300).

During the time when the National Council for Accreditation of Teacher Education (NCATE) set standards for elementary preparation programs, candidate knowledge of science, technology, inquiry, science in personal and social perspectives, and the history and nature of science were expected. Additionally, NCATE stipulated that candidates should be able to use and apply concepts and inquiry (NAP, 2007).

> The 'inquiry' standard indicates that an 'acceptable' elementary candidate would demonstrate an understanding of the abilities needed to do scientific inquiry but provides no further definition of what inquiry is, the attendant abilities, nor descriptions of performances that would be indicative of satisfactory understanding. (NAP, 2007, p. 300)

The scientific knowledge of K-8 teachers is often quite vague and provides researchers with many questions to ask and answer regarding teacher preparation preservice and during their current teaching role. Influences likely to contribute to this tendency are narrowly focused preservice college preparatory courses, little or no professional development, and an unsatisfactory credentialing process for current K-8 science teachers (NAP, 2007). Teachers tasked with ensuring that students reach national, state, and district science standards must have explicit preservice training, professional development, and collaboration with other professional teachers of science education to develop a deeper understanding and pedagogical skill of science to provide quality instruction and activities in the classroom.

One evidence-based question raised by researchers in many studies "on teachers' dispositions teachers' espoused beliefs about science teaching and their instructional practices to make inferences about their views on learning" (NAP, 2007, p. 301). Previous studies concerning science education contain minimal research designs, and often, researchers used insufficient samples of one to three science educators. Even worse, previous research is also filtered with a view of teaching and learning that misleadingly suggests that science instruction is only effective when it is student-centered. This interpretation of science instruction leads educators, educational leaders, and educational advocates to promote the use of inquiry and investigations and reject the idea that teachers understand what their individual students' needs and interests are and prepare and plan lessons and activities accordingly.

There was developing work on "folk pedagogy" or popular belief systems about how students learn and what teachers can do to increase learning outcomes that provides some insight into how stakeholders commonly, and some teachers, think about learning (NAP, 2007). This work rests on the proposition that teaching is an inherently human practice, people continually teach one another, and in doing so, develop working (although often implicit) philosophies of pedagogy (NAP, 2007). Folk pedagogy is evident across age extents and diverse populations and represents a shared, working belief about education (NAP, 2007).

When teachers' explicit mental models of learning were examined, attempts were made to define the process for learning. In one study, interviews were conducted of science and humanities teachers. These teachers explained their strategies for teaching difficult material and found a common mental model. Teacher conceptions were that learners attempted to connect small pieces of new learning to prior knowledge (NAP, 2007).

Teachers' theories about student mental models provide another factor in science instruction. Strauss (as cited in NAP, 2007) described a mental model in which teachers "chunk" instruction into manageable parts. In contrast, researchers argued that science instruction involves participating in scientific practice wherein learners engage in meaningful problems over time (NAP, 2007). This researcher's purpose was to demonstrate how science instruction at the elementary level would be more beneficial if taught in a departmentalized setting, respective of ELA and math curriculum provided in the regular education classroom. Science instruction at the secondary level is taught separate from other curricular subjects; the aim of Straus' study was to provide evidence that if science was treated with the same respect, teacher pedagogical skills and knowledge would increase which, in turn, would have a positive and direct impact on student achievement scores on science state assessments. Although there is no empirical research that examines how teachers' perceptions of students influence student learning outcomes, researchers focus their efforts on this finding because it leads the way to both a potential tentative suggestion for instructional reform and further research (NAP, 2007).

History of Science Courses in American Schools

Since the 1800s, American public schools did not consider or require science standards to be a basic necessity. Early schools were also concerned with mastery of literacy and numeracy standards, which translates to ELA and mathematics. In earlier years, high schools were primarily focused on preparing students for careers in law and the clergy. Science courses and standards acted as electives and required exposure to technology courses such as navigation, surveying, and agriculture. Not until the twentieth century did Next Generation Science programs begin to produce standards, curriculum, and activities requiring proficiency in science and technology (Champagne, 2007).

Science courses, standards, and curriculum below the high school level (Grade 10) have diverse and inconsistent histories. Science courses at the seventh, eighth, and ninth grade were not introduced until midway through the twentieth century. The middle school science curriculum was similar to high school science, but instructional blocks were explicitly used to teach general science. General science included biology, chemistry, physics, and earth science. To support staff professional development and training, 1960s educational leaders found ways to integrate all science topics and standards into one all-inclusive course. The goal was to create life, physical, and earth science courses for middle schools (Champagne, 2007). Throughout the 1970s and 1980s, middle schools included ninth grade, high schools were grades ten through twelve, and sixth grade was transitioning into becoming a part of the middle schools (Yager, 2020). In 1996, middle grades were defined as grades five through eight by the National Science Education Standards (Yager, 2020). It was a cultural norm for middle school teachers to collaborate as teams to create lessons and activities from all four science standards that would be taught to a purposefully formed group of students. Students were placed in cohort groups to receive instruction and work on lessons and activities (Yager, 2020).

Science at the elementary level was considered a rarity until the middle of the twentieth century (Yager, 2020). There are standards, textbooks, and curriculum with the requirements and pacing guides for science instruction; however, science was not taught consistently (Yager, 2020). Educational leaders have been pushing teachers to focus their efforts on mathematics and ELA proficiency; therefore, instructional time allotted for science and social studies blocks is “borrowed” to ensure strict adherence to mathematics and ELA pacing guides (Assistant superintendent of learning services, personal communication, August 9, 2021). Classroom teachers attend professional development and training that does not prepare for science lessons and instruction, and there was no procedural way to measure and assess science learning across grade levels.

The Role of Science and Technology Education

With technology and science ever-changing and growing, there is a push to become more literate and skilled in living, working, leisure, international competitiveness, and resolution of personal and societal issues. As far as science is concerned in education, especially elementary education, it is not considered a top priority when school leaders prioritize common core standards. Science and social studies take a backseat to mathematics and ELA due to the push for third-grade reading proficiency and college and career readiness (Academic Partnerships, 2021).

Many international educational leaders would not consider technology to be an area of study for college students. National and international leaders are now focusing their efforts on merging science and technology curriculum and standards in K-12 schools to better prepare educators for careers in the STEM fields (Academic

Partnerships, 2021). Yager (2020) voiced agreement with the facets of science proposed by Simpson in a 1963 article published in *Science*:

1. Asking questions about the natural universe, that is, being curious about the objects and events in nature.
2. Trying to answer one's own questions, that is, proposing possible explanations.
3. Designing experiments to determine the validity of the explanations offered.
4. Collecting evidence from observations of nature, mathematical calculations, and, whenever possible, experiments that could be carried out to establish the validity of the original explanations.
5. Communicating evidence to others, who must agree with the interpretation of evidence for the explanation to become accepted by the broader community of scientists. (Yager, 2020, para. 4)

The purpose of merging science and technology curriculum in K-12 schools has been to produce college and career-ready students and graduates who are skilled and knowledgeable in the STEM fields. Beginning in 1980, NSTA has identified and described STEM literacy as the major goal of science instruction and explained what STEM literacy would entail. *NSTA Handbook, 1999–2000* defined a scientifically literate person as one who can

- Engage in responsible personal and civic actions after weighing the possible consequences of alternative options.
- Defend decisions and actions using rational arguments based on evidence.
- Display curiosity and appreciation of the natural and human-made worlds.

- Apply skepticism, careful methods, logical reasoning, and creativity in investigating the observable universe.
- Remain open to new evidence and realize the tentativeness of scientific/technological knowledge.
- Consider the political, economic, moral, and ethical aspects of science and technology as they relate to personal and global issues. (as cited in Yager, 2020, para. 8)

School districts are tasked with producing graduates who possess the knowledge and pedagogical skills required to meet Common Core standards of proficiency for science and technology. Each district identifies curricular goals that must be accomplished by the curriculum implemented towards student outcomes. The 1996 National Science Education Standards, as reported by Yager (2020), set out just four goals, namely the production of students who:

- Experience the richness and excitement of knowing about and understanding the natural world.
- Use appropriate scientific processes and principles in making personal decisions.
- Engage intelligently in public discourse and debate about matters of scientific and technological concern.
- Increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their fields. (para. 10)

Science Instructional Settings

Open the textbook, read the passage, and answer the questions is the predominant technique of how traditional science instruction is delivered: the teacher-centered approach (Elliott, 2020). Students are delivered the instruction, may or may not participate in some supporting activities, observe the teacher conduct experiments and investigations, and are asked to write about their experience. The Next Generation Science Standards are aligned around three strands: Disciplinary Core Ideas (scientific concepts), Science and Engineering Practices, and Crosscutting Concepts (Zahradnik, 2018). "Science instruction should include all three strands for an effective science experience" (Zahradnik, 2018, para. 5). The disciplinary core ideas have broad importance within or across science or engineering disciplines, provide a significant tool for comprehension or mastery of investigating complex ideas and solving problems, correlate to societal or personal concerns, and can be taught over numerous grade levels at progressive levels of depth and complexity (Zahradnik, 2018).

Zahradnik (2018) identified eight practices or actions for students to actively participate in during science instruction:

- Ask Questions and Define Problems
- Develop and Use Models
- Plan and Carry Out Investigations
- Analyze and Interpret Data
- Use Mathematics and Computational Thinking
- Construct Explanations and Design Solutions
- Engage in Argument from Evidence

- Obtain, evaluate, and communicate information. (para. 6)

Students might engage more with science if lessons and activities provide hands-on, investigative opportunities.

> Students should have the ability to solve problems that interest them, have context in their lives, and help them understand natural phenomena. For students to become critical thinkers and problem-solvers, educators must follow an instructional lesson flow when delivering science instruction. Science instruction should commence with some type of active investigation or activation of prior knowledge followed by a question to be answered or a problem to be solved. (Zahradnik, 2018)

Students are then to plan an investigation (or are guided through how to complete an investigation) to gather evidence that will support their response to the question or resolution to the problem (Zahradnik, 2018). After obtaining some evidence, students should evaluate the data and ascertain the next steps; conceivably, they could revisit their model and make changes or revisions, or perchance they could consider some additional trials (Zahradnik, 2018). Finally, after evaluation and revision, students can then claim that they support the evidence gathered from the investigation and the reason the evidence connects with the claim (Zahradnik, 2018).

Another approach to student-centered science instruction is the 5E model of instruction, an inquiry-based model. This model is student-led, allowing the teacher to facilitate lesson components while the students are in charge of performing the activities. Students are engaged in open-ended questions, real-life experiences, guided investigations, hands-on projects, and research and are able to gain a deep understanding of the scientific topics that are covered in each unit (Elliott, 2020). Each stage of the 5E model serves as a foundation to the next, creating a coherent model that frames lessons, activities, and units (Elliott, 2020).

The traditional method of teaching science was the way many students have been learning for centuries. The traditional method only allows students to be passive recipients of information delivered by their teachers. Researchers are now finding more innovative approaches to deliver more enjoyable, engaging, and inquiry-based lessons and activities. Current studies show that students are better able to deepen their knowledge and skills when they are fully engaged in defining the problem and coming to a solution through collaboration and problem solving with their peers (Elliott, 2020). Students are able to understand the many facets of scientific phenomenon with more depth through this approach. The historic geniuses of science taught themselves science through this inquiry-based method outside of the traditional classroom.

A template including a description for each of the phases in the 5E model of instruction is included below. It provides a detailed account of what it would look like when a science teacher provides inquiry-based, guided science instruction.

Engagement. Student interest is engaged. Students ponder everything they already know about a topic. The teacher identifies any misconceptions at this point.

Exploration. Students explore the topic through hands-on activities. They gain experience with the topic and reflect more on what they know and experience with their classmates. The teacher continues to guide by asking open-ended questions.

Explanation. Students connect prior knowledge to experiences in the exploration. The teacher explains the concepts, and students draw conclusions about their investigations.

Extension. Students take their new knowledge and apply it to novel situations. The teacher poses new questions and provides opportunities for students to investigate answers. This is when knowledge about specific topics begin to generalize and deepen in students' minds.

Evaluation. Students evaluate their learning process. They are able to prove what they know by performance, as well as by informal and formal assessment. The teacher uses multiple forms of assessment to evaluate the students. (Elliot, 2020, para. 15)

Departmentalized Structure (Science Specialist Model)

What we know about elementary science is that it is underrepresented in the classroom as well as in the research. A dearth of research studies exists while most are focused on the efficacy and implementation of science specialists in elementary schools. A considerable amount of literature approaches science instruction from the philosophical or descriptive level without offering empirical value or in-depth analysis. The literature review from Marco-Bujosa and Levy (2016) provided 14 articles on the topic of elementary science specialists; however, of the 14 articles included, only two studies could be characterized as rigorous research because they were the only studies that included a specific defined research question, provided data collection, analysis, and results that answered the preliminary research question.

Marco-Bujosa and Levy (2016) offered the sole empirical evaluation of the effectiveness of specialists compared with classroom teachers. The researchers also compared the teaching and learning provided in a district with elementary science specialists to a district that follows the traditional classroom teacher approach. The district utilizing the science specialist tasked the specialist with planning activities and instruction for all elementary grades. The classroom teacher was responsible for lesson facilitation, follow-up, and assessments. Specialists were required to meet with Grades 4-6 twice each week. The evaluation was based upon (1) a survey of teacher views and opinions regarding science education; (2) sample lesson plans submitted by the teachers to address specific topics at each grade level that were analyzed for the alignment of teaching goals to the National Research Council (NRC) (2000) and the American Association for the Advancement of Science (1993) standards; (3) student performance on state assessments; and (4) samples of student work from classroom activities (Levy, Pasquale, & Marco, 2008).

Results from the study conducted by Levy et al. (2008) helped researchers assert that specialists held a view of science teaching and learning that was more consistent with the reform agenda in national science education research. New reform efforts emphasize the need for students to be engaged in lessons and activities that provide opportunities to develop problem-solving and thinking skills versus traditional textbook-based instruction. Classroom teachers who were survey participants in the study claimed to advocate for the inquiry approach to science instruction; however, analysis of lesson plans revealed a clear contradiction between teacher beliefs and perceptions compared to their actual lesson plans and instruction. Lesson plans revealed a more textbook-based approach to science rather than creative, hands-on lessons with time for collaboration, exploration, and experimentation toward solving problems. Conversely, the specialists' lesson plans sustained the primary focus on developing students' problem-solving and critical-thinking skills. Garrett (2008) found that those teachers who taught in the traditional model were more concerned with classroom management while the specialist was more interested in student participation through hands-on and problem solving (Garrett, 2008).

An analysis of student outcomes of state standardized assessments for fourth through sixth grade science found no statistically significant difference between student performance, whether they were taught using the specialist or the traditional model. However, Levy et al. (2008) pointed out an important caveat: standardized exams currently only test student mastery of lower-level knowledge and comprehension. With this fact at the forefront of researchers' minds, samples of student work, projects, and classroom assessments were collected and analyzed for evidence of student thinking and problem-solving processes. Student work samples provided evidence that students taught by a specialist were taught how to use higher-level thinking and problem-solving skills. Students were able to identify a relationship between research questions and lab or experimental results. Overall, specialists provided lessons and activities that prepared students for proficiency on standards and targets addressed on standardized assessments while also deepening their problem-solving and thinking skills. Classroom teachers in the traditional models lacked expertise in deepening students' problem-solving and thinking skills.

Schwartz et al. (2008) concluded from Levy et al. (2008) that "students taught by science specialists (a) were engaged in open-ended, inquiry-oriented, science-based activities of the kind often advocated, but mostly absent, in elementary school, and (b) demonstrated problem solving and higher order and critical thinking skills" (p. 1). Results from the Levy et al. (2008) study suggest that student achievement can positively be impacted by having a specialist rather than a classroom teacher facilitate science instruction. Specialists' models are more effective at raising student outcomes when considering problem-solving, thinking, and pedagogical skills in the classroom through providing rich, hands-on inquiry instruction.

Although findings by Schwartz and Gess-Newsome (2008) strongly suggest that elementary science specialists are more effective instructors of inquiry-based science, supporters of the traditional model could also see the value of utilizing the specialists in a professional development and training capacity. The analysis showed that the specialist district required the science specialist to present lessons and activities with students. District leaders consider the most cost-effective approach to science professional development and training is to charge the specialist with presenting transformative, inquiry-based lessons and activities to students.

Levy et al. (2008) and Schwartz et al. (2008) performed building level and classroom level observations, interviewed teachers and building leaders and administered surveys to teachers and building leaders to compare the three basic models for elementary science instruction:

1. Classroom teacher model: the basic model for instruction in which one teacher is responsible for teaching all subjects in a self-contained classroom.
2. Science resource model: the specialist provides technical assistance to the classroom teacher who maintains primary responsibility for instruction,

3. Science instructor model: one individual is hired specifically to teach science across a variety of grade levelsl (Levy et al., 2008, p. 6)

Current elementary science instruction studies continue to uncover that when a specialist teaches science, the curriculum, lessons, and activities are more closely related to the new standards for science instruction and common core. Students of specialist instruction also show more knowledge of problem-solving strategies, creative inquiry or exploration, and scientific concepts, content, and pedagogy. Jones and Edmunds (2006) also discovered that in districts utilizing the specialist for science instruction, students were provided with more opportunities to work in labs, engaged in hands-on activities, had more resources and materials beyond the science textbook, and given more attention and praise was given to their displays and assignments. The "specialists in the school, in whatever discipline, may result in an increased physical presence of that discipline in the school" (Levy et al., 2008, p. 334).

Existing programs for teaching science at the elementary level fall into four categories or models:

1. Classroom teachers are responsible for teaching science;
2. Classroom-based science specialists with their own regular classrooms provide resources and support for other classroom teachers;
3. School-based science specialists provide direct instruction to students within or across grade levels; and
4. District-based science specialists serve as a resource and support to classroom teachers in several schools. (Levy et al., 2008, p. 6)

Results from the Levy et al. study's analysis indicated that collaboration between the science specialist and classroom teacher rarely occurs. Teacher interest, professional development, and ownership of science instruction alone are not effective in increasing student outcomes; support from building leaders is essential for analyzing, improving, and implementing science initiatives. This seems to confirm that, from results reported earlier by Rhoton, Field, and Prather (1992), best practices and ground-breaking approaches to the specialist model can be implemented at the building and district level, requiring the building principal, classroom teacher, and science specialist to attend professional development, training, and collaborative planning sessions together to invest in "instructional skills, administrative insights, and content knowledge" simultaneously.

In general, results from Levy et al. (2008) emphasized several important points:

1. Science specialists can be school-level science experts, and their knowledge and experience can be used in a variety of ways to meet the financial and logistical needs of the school or district.
2. Specialists can be an excellent resource for professional development, if school structures are established to facilitate communication and observation.
3. Principal involvement is crucial, and school structures need to be in place to support the work and influence of the teacher-initiated change.
4. Treating science as separate from the rest of the curriculum in the elementary grades may be a mistake, particularly if connections are not made across the curriculum. (p. 8)

Naysayers of science teacher specialists would stress that classroom teachers can also develop feelings of inadequacy and inferiority and experience increased anxiety and avoidance of teaching science when there is a specialist present (Levy et al., 2008). Building and district leaders are cautioned to share the knowledge and delegate teacher preparation to numerous experts to avoid staff burnout and one-sided thinking. Students may benefit more from having multiple professionals present different types of lessons, topics, and content to connect with their other curricular courses. Nevertheless, in a time of competing curricular demands at the elementary level, rising stakes for science, and financial cuts, the field must provide best practices to guide the decision-making efforts of elementary schools to improve their science instruction (2008).

Traditional Structure (Classroom Teacher Model)

The structure of elementary science is multifaceted and ever-changing. Nationwide educational leaders focus their efforts on increasing proficiency in reading, writing, and mathematics; therefore, science has taken a backseat to ensure that third grade reading outcomes are met (Hill, Corbett, & St. Rose, 2010; National Center for Educational Statistics, 2007). Science researchers, advocates, and enthusiasts are showing increased interest and demand for high-quality elementary science instruction. Reforms in K-12 science have been inspired by America's persistent low and inequitable achievement in science (Hill et al., 2010; National Center for Educational Statistics, 2007; NRC, 2011) and subsequent apprehension about future career and economic competitiveness and affluence.

Hill et al. (2010) asserted that researchers envision a rigorous elementary science program and standards assimilating innumerable scientific, technical, and engineering concepts and disciplines. It is becoming increasingly important for teachers to develop a deeper understanding and pedagogical skill to better prepare and deliver more engaging and effective inquiry and problem-solving science lessons and activities. Teachers of science are given opportunities to collaborate with other educators to develop new theories, depictions, and explanations of scientific phenomenon. Regrettably, this is not a common practice for professional development and training at the elementary level.

Numerous researchers have found elementary teachers wishing to gain additional science-teaching knowledge, including science content and pedagogical knowledge, knowledge about instructional practices, and knowledge about the nature and practices of science (Greenwood & Scribner-McLean, 1997). An essential significance of the traditional classroom, insufficiencies in content knowledge, pedagogical skill, and confidence of elementary teachers can be accredited to the multifaceted role they play in the classroom such as mathematics instructor, language arts instruction, and in addition to science educator. Some researchers have pinpointed elementary teachers' lack of assurance and interest in science and deficits in cognitive and reasoning ability (Tilgner, 1990).

Lack of science knowledge, interest, pedagogical skill, and reasoning or problem-solving abilities among a non-specialist population of educators, such as elementary teachers, supports the assertion that the K-12 science education system needs reform (Mensah, 2012). Teacher readiness for science instruction has recently been classified as another critical issue identified on a survey of classroom generalists. Only 25% of regular education classroom teachers considered themselves highly qualified and prepared to deliver effective and engaging science instruction (Marx & Harris, 2006).

Carlone, Scott, and Lowder (2014) have uncovered a multitude of building and district-level factors that coerce elementary science transformation or lack thereof, along with the teacher-centered factors. Inconsistent instructional blocks and frequency, inadequate materials, resources, equipment, budget, space, and amenities are among the main issues. Additionally, educators in urban districts have reported at least since the early 2000s (Garrett, 2008) that it is difficult to supervise and maintain classroom management and high structure when engaging students in inquiry-based exploration, lessons, activities, and projects. Science educators have reported difficulties in classroom management practices during inquiry and exploratory science instruction for two decades; science enthusiasts are asked to find ways to maintain high structure during student-centered activities.

One purpose of professional development and training for science education is to address barriers to elementary science instruction (Cooke-Nieves, 2011). The most impactful barrier to elementary science professional development and training is that districts and schools prioritize mathematics and ELA instruction over science instruction. (Cooke-Nieves, 2011). This practice puts science collaborative planning on hold so student outcomes in mathematics and literacy approach proficiency. Successful professional development in elementary science may occur through induction, mentoring, modeling, and in-service workshops and should include rich content and pedagogical knowledge coherently linked with the anticipated needs of the teacher during implementation.

Educators have reported that collaborative science discussions have consisted of curriculum resources and materials rather than actual lesson, activity, and assessment discussions (Cooke-Nieves, 2011). Teachers are most interested in what materials are needed, when to use them, and how, so it is difficult to move them into more in-depth lesson planning discussions when they struggle to develop a familiarity with materials they are expected to use (Cooke-Nieves, 2011). The goal of elementary science professional development and collaborative training is to address the need for content knowledge and develop teachers' pedagogical skills. Elementary science teachers feel ill-prepared for science instruction; they struggle to identify what and how they should seek deeper comprehension (Cooke-Nieves, 2011). They do not yet know what they do not know about science education, data, and best practices to ask specific questions to enhance instruction. Forbes and Davis (2008) shared how pre-service teachers developed a curricular role identity as a result of working, adapting, and enacting curriculum materials alongside experienced science teachers. Classroom teachers feel supported when they are given opportunities to engage in meaningful professional development and collaborative discussions.

Elementary Science and Science Specialists

A major effort being made by science reformers has been to implement a science teaching specialist. This model is utilized in elementary schools to provide a specialized approach to science aside from mathematics and literacy provided in the regular education classroom. The basic rationale is that a science specialist is an expert in science content and pedagogy and, therefore, better suited to teach elementary science (Yearwood, 2011).

> The issues faced with the science specialist approach are determining what qualifications, content knowledge, pedagogical skill, and preparatory skills a specialist should possess or obtain to be considered highly qualified for the

> position. Such a teacher should have "a strong background in biology … chemistry, physics, astronomy, and geology. (Hounshell, 1987, p. 157)

Abell (1990) stated that he "prefers the depth of a "major in science at the undergraduate level … and concomitant professional training for teaching elementary science" (p. 293). A teaching specialist should be skilled in meaningful collaboration with other educators and show an exceptional interest, experience, and comprehension of their subject of expertise.

Implementing a teacher specialist model provides students and teachers with more impactful instructional practices, consistent exposure, and immersion in science education. Specialists should possess a superior pedagogical ability to positively impact the teaching and learning of science education in the buildings they serve (Abell, Park, Rogers, Hanuscin, Lee, & Gagnon, 2008). Within this general rationale, numerous "specialist" models have been proposed and implemented. Abell et al. (2008) described the concept of pedagogical content knowledge (PCK) (para 1). The teacher specialist model seems to provide for the implementation of this concept.

Schwartz and Gess-Newsome (2008), described a departmentalized model, in which subjects are assigned for each grade-level team. Each teacher is assigned a core subject and students are rotated among their grade-level teachers placed in charge of each subject. Other variations of the use of a specialist model incorporates the specialist educator as the teacher of teachers to prepare classroom teachers for delivery from explicit professional development and training. This approach has been termed the resource/coaching model by Schwartz and Gess-Newsome (2008). Instruction can also be delivered in a co-teaching fashion taught by the specialist parallel teaching with the classroom teacher to support the immediate needs of the teacher and students during instruction. Reid (2012) advocated specialist instruction for both mathematics and science, proposing team teaching and mentor teaching as solutions.

In theory, the science specialist assists the classroom teacher during exploratory, inquiry, and hands-on activities to extend the regular textbook approach to science education. The specialist can explicitly teach students and the classroom teacher which materials and resources are required for each lesson, when to use them, and how to use them. Nelson and Landel (2007) advocated for departmentalizing the upper elementary grades to allow teachers to specialize in areas of demonstrated effectiveness. Departmentalized models have also used the teaching specialist to plan and create lessons while the regular education teacher aligns lessons and activities with the curriculum and standards and is in charge of delivering lessons to their students.

Skeptics of the specialist model have argued that if a specialist teaches science, it would free teachers to neglect their teaching responsibilities and take advantage of the extra time in their schedules. However, supporters of the specialist model rebutted that specialists are to collaborate, plan, co-teach, observe, and provide feedback to regular education teachers to improve the teaching and learning of science education (Gerretson, Bosnick, & Schofield, 2008). Educational leaders have observed the differences in the roles that classroom teachers and specialist teachers play in each of the four identified models. Best practice is to determine which approach would best meet the needs of students and educators at the building level so that the specialist and classroom teachers are used in their strongest capacity to improve student outcomes in science education. Building and district leaders must determine which variant of the specialist model will yield the most positive support for teachers and student achievement (Gerretson et al., 2008).

A significant difference of the “pull-out” model is that the specialist is responsible for teaching all science lessons to all grade levels, such as physical education, music, and art instruction. The classroom teacher is not involved in the planning, delivering, or assessing of the science curriculum (Gerretson et al., 2008). The departmentalized model assigns core subjects to one grade-level teacher. Students rotate to receive instruction from multiple teachers rather than stay with their classroom teacher to receive all core instruction. The “resource” and “co-teaching” models require the teaching specialist to provide professional development and training to the classroom teacher and provide support during collaborative discussions (Gerretson et al., 2008).

The detailed job descriptions and roles of the science specialist differ significantly across frameworks. District leaders must also consider the difference in funding required to implement each subject to decide which approach works best for students and budget constraints of the district (Ronan, 2014). Co-teaching structures require both teachers to be compensated for their work. Science specialists expected to provide professional development or leadership in science may also command higher salaries (Ronan, 2014). The variability between each specialist role makes it extremely difficult for researchers to determine which model is most effective.

The debate among science intellectuals and enthusiasts has continued for some time, and agreement with the idea of departmentalizing science instruction as a part of that debate remains (Swartz, 1987). Some argue that opportunities for interdisciplinary connections and teachable moments may be lost as the classroom teacher loses touch with science instruction, and the specialist is unavailable for the remainder of the school day (Ronan, 2014). In a pull-out model of science instruction, both teachers and students could begin to disassociate science with their other core subjects and treat it as other specials courses (physical education, music, art, etc.). Science could become even more excluded from classroom discussions and practices if it is no longer part of the regular education classroom. This outcome would contradict efforts to provide teachers and students with more opportunities to engage in science discussions and activities and connect with other core subjects and real-world interactions that could be useful in their future college and careers.

The use of the specialist model could increase the likelihood that classroom teachers would engage in professional development, collaboration, and meaningful discussions in the classroom and with staff concerning science topics and ideas (Schwartz & Gess-Newsome, 2008). Doing so would enable regular education teachers to increase content knowledge and pedagogical skill in science education. The result could be the "centralization of science enthusiasm in a small number of individuals rather than across a dispersed leadership capacity" (p. 26). This centralization might incline the science department to withstand issues with a turnover of specialist teachers, which could have a detrimental impact on the culture and stability of science teaching and learning at the building level. The scope of these undesirable influences is contingent on the specific specialist model and the identified roles and responsibilities of the classroom teacher versus or in concert with the specialist.

Implementing and Evaluating Science Specialists

Although there are numerous hypothetical academic and opinion studies, elementary science continues to suffer from a dearth of published empirical studies concerning the specific types of science specialists approaches. The science specialist approach suffers from that absence that could demonstrate the effectiveness of each program structure. Researchers Schwartz, Adb-El-Khalick, and Lederman (2000), have examined the effectiveness of elementary science teaching specialists' impact on teacher and student outcomes.

Schwartz et al. (2000) compared two suburban school districts, one that implemented the specialist model and the other that implemented the traditional classroom model. Science specialists developed lesson plans and co-taught science with classroom teachers. Classroom teachers were available during explicit instruction. Lessons were co-taught so that the classroom teacher was present to assist with lesson materials and activities. Regular education teachers were required to plan, collaborate, assist, and assess students. Classroom teachers were involved as decision-makers responsible for gathering and interpreting data. This data gathering allowed collaboration with the specialist and the use of findings to make instructional decisions based on student outcomes. The results of the study concluded that "students taught by the science specialists (a) were engaged in open-ended, inquiry-oriented, science-based activities of the kind often advocated, but mostly absent, in elementary school, and (b) demonstrated problem solving and higher order and critical thinking skills (para. 1).

Cooke-Nieves (2011) determined that the science specialist model was effective upon close analysis of student achievement scores. Additionally, researchers also uncovered a statistically significant difference in the national science standards alignment found in lessons taught by a specialist. Cooke-Nieves (2011) also discovered that the district with the specialist teacher leading instruction also showed the least alignment with inquiry-oriented lessons and activities when compared to national standards for inquiry-based science instruction. This atrophy in teacher content knowledge and pedagogical skill could be directly related to teachers no longer being tasked with ongoing science standards alignment and preparation as they did in the traditional model for science instruction, with the primary teacher delivering science instruction. Statistically significant differences in student achievement scores were not found as researchers had anticipated (Cooke-Nieves, 2011).

Cooke-Nieves (2011) interpreted study data to show that although students in the specialist-led districts were exposed to more inquiry-based instruction, it did not indicate a statistically significant increase in student achievement scores on state assessments. Cooke-Nieves gathered information about students' exposure to inquiry-based instruction, not through lesson observation but analysis of teacher and specialist lesson plans. Comparisons in lesson plans suggested that specialist teachers provide students with more opportunities and exposure to inquire instruction than classroom teachers (Ronan, 2014). The specific roles provided by the specialist must be kept in mind when evaluating this study, as these features differ significantly (Ronan, 2014). Variances in science-teaching aptitude between classroom teachers and science teaching specialists will be contingent on the credentials and abilities of each teacher.

In large urban school districts, science teaching specialists can have a wide variance in their roles and responsibilities within each school (Cooke-Nieves, 2011).

Depending on the criterion and job descriptions detailed in the verbiage of the teacher contract, a science teaching specialist could be considered ill-prepared or underqualified for one building and could better serve at another building. There is also the point of the variances in science curriculum and materials for science educators at different districts. Cooke-Nieves wanted to account for the differences in classroom teachers and specialists relying on scripted lessons and curriculum compared to districts that allow teachers autonomy in choosing curricular materials and resources. There could also be an analysis of teacher's reliance on scripted curriculum versus authentic lessons and activities (Cooke-Nieves, 2011). Large urban schools usually implement a scripted curriculum to help guard against large differences in student transfers of information across schools within the district, hold teachers accountable for adhering to a scheduled pacing guide, and align with district, state, and national science standards at the elementary level (Cooke-Nieves, 2011). The purpose is to best prepare student test takers for success on state assessments regardless of the school they attend. All students should have the same chance of scoring proficient on state assessments because they would have been exposed to the same curriculum during the same time frame and frequency prior to test completion. High-stakes testing is a significant component of school culture in the era of accountability ushered in by the No Child Left Behind Act (NCLB) of 2001 (2003). This pattern is correct and critical in large underperforming urban districts.

Although science has recently been added to the list of required assessments, student scores did not impact districts and schools meeting the adequate yearly progress (AYP) standards. In layman's terms, student performance on science assessments is not as critical as their mathematics and literacy performance scores. Conversely, there may be benefits in retaining a low-profile status for science at the elementary level; as Carlone et al. (2014) wrote, “There is a certain amount of freedom that accompanies the teaching of a non-tested subject and more teacher autonomy, not narrowly prescribed, oppressive meanings of ‘elementary science teaching’ for teachers to be forced to take up” (p. 959).

Core subjects that take precedence over other core subjects require more scrutiny, observation, accountability, and less autonomy is given to elementary classroom teachers (Carlone et al., 2014). Teachers are under a rigid lens for following the scope and sequence with strict adherence to state standards for mathematics and literacy to support the push for third grade reading proficiency; however, science standards are not directly associated with college and career readiness as outlined in the verbiage of the mission, vision, and strategic plans of schools. Few states have developed an annual testing requirement for science at either fourth grade or fifth grade, but elementary students in third through fifth grades are required to complete yearly mathematics and literacy assessments. Primary grade teachers (kindergarten through second grade) are not under the testing umbrella. They are only affected in preparing students with the foundational skills for success in mathematics and literacy that support standards that are assessed in the intermediate grades.

Teacher Professional Development and Planning

Science teaching and learning are directly affected by the structure and culture of the building where science is being taught. Some districts de-emphasize science to push educators to raise student outcomes in mathematics and English language arts, while other districts value and sustain the importance of what science education brings to the overall knowledge and pedagogical skills. The goal of supporters of the science specialist model is to advocate for the importance of the positive impact these educators have on teachers' professional development and training and the more in-depth knowledge and skills shown by students in daily lessons, activities, and assessments (Levy et al., 2008).

Specialists must feel supported by district and building leaders to be effective with staff and students. The necessary supports with the most influential impact on specialists' ability to work as efficiently and effectively as possible come from the following four sources: colleagues, peers, classroom teachers, building leaders, district leaders, organizations, and institutions that support science and higher education (Levy et al., 2008). The most critical questions that researchers should investigate come from data collected from teacher surveys or interviews concerning the extent of the structures in place for collaboration, professional training, and development regarding elementary science education (Levy et al., 2008).

Researchers of science education must shed more light on the specific responsibilities of the science specialist when interacting with students while also defining their role in collaborating with classroom teachers. Survey and interview questions should answer the unknown about the culture at the building and district level regarding fostering a professional learning community and how, if at all, the science specialist is included (Levy et al., 2008). How often, to what extent, and in what compacity the specialist leads or participates in professional development or training sessions can also determine the effectiveness of the specialist.

Levy et al. (2008) asserted that the nature of impacts on elementary classroom teachers centers on how their science instruction has changed as a result of their work with a specialist. Therefore, questioning if students are receiving more science instruction or more effective science instruction as a consequence of the model of instruction that is being implemented is critical (Levy et al., 2008). The major struggles faced by researchers and supporters of science is quantifying the amount or quality of science instruction. Furthermore, teacher perceptions and outcomes are also vital data needed to make an informed decision about science education. These relate to those arbitrating factors and influences that avert many classroom teachers from confidently teaching science. Such factors include a sense of inadequacy, lack of content knowledge or pedagogical skill, or possessing only a surface-level understanding of how the science curriculum can be integrated with other subject areas (Levy et al., 2008). Increasing teachers' understanding of educational issues associated with science could prove to be the first and most critical step in raising awareness and building a school or district-level culture that appreciates the benefits that science education can have on education, the workforce, and the economy.

Instructional Frequency and Duration

"According to the National Survey of Mathematics and Science, the average number of minutes per day teaching science in Grades K-3 has declined from 24 in 2000 to 19 in 2012 and from 31 to 24 in grades 4-6" (Leader in Me, 2020). Some educational leaders might argue that ELA and mathematics "take precedence, especially in the early elementary years, when learning to read is a primary focus" (Leader in Me, 2020). Science lessons and activities are those in which students can apply collaboration and teamwork skills, creativity and imagination, critical thinking, and problem solving which are necessary for proficiency in ELA and mathematics instruction.

Regardless of the instructional model being implemented, science instruction must be treated with the same priority as ELA and mathematics instruction. Career focused education from University of Manchester calculated that, on average, primary level students received an hour and 24 minutes of regular classroom time each week to science (George, 2017). The report helps researchers conclude that, on average, across all primary school year groups, 58% of classes did not get two hours of science per week. Researchers stress that once additional activities were included, such as science-related school trips, the subject is taught, on average, for the equivalent of one hour and 42 minutes a week. In this measure, 54% of primary school classes did not receive the equivalent of two hours of science instruction weekly. Studies also show that the amount of science instruction increases as students move into middle and high school when students are taught science as a separate course (George, 2017).

The Importance of Frequent, Consistent, Coherent Science Instruction

One of the conceptual shifts introduced in the current instructional framework and promoted by Next Generation Science Standards (NGSS) is that science instruction must be delivered consistently and coherently at every grade level (NGSS, 2013). To the layperson, making an elementary science structure reform from a self-contained classroom to departmentalized would not seem like a major paradigm shift; however, researchers struggle to support the need for such a change across districts and states. It was not until the late 1990s and early 2000s that the United States began prioritizing mathematics and literacy proficiency performance outcomes at the elementary level; in turn, this forced teacher’s hand at “borrowing” time from the allotted science blocks to cover standards and topics addressed on state assessments (NGSS, 2013). Elementary educators admittedly began eliminating science education from their daily schedule altogether.

In 2002, the Bush administration proposed No Child Left Behind, an educational law requiring annual, standardized testing in mathematics and language arts (Klein, 2015). The response to this congressional act was that thousands of schools across the nation reduced instructional time spent on non-tested subject areas such as science and social studies (Dillon et al., 2006). Researchers Keegan and Bower (2006) conducted a study of elementary schools and reported a drop in weekly minutes of science instruction from 99 minutes per week, less than 20 minutes daily. Some districts reported having reduced science and social studies blocks, down to two shared 45-50-minute blocks two days each week. Keegan and Bower (2006) reported the national average time spent on science instruction to be 16 minutes each day.

As pressure to meet AYP endorsed by No Child Left Behind (NCLB), elementary teachers prioritizing subjects and standards assessed on state assessments began focusing their daily instructional efforts and interventions on raising student outcomes in mathematics and literacy. Science was slowly losing its value in the regular education classroom. In 2007, science assessments for fifth-grade elementary students were added to the assessed standards on state assessments, yet, this did not positively impact teacher’s daily instructional practices. Science was still treated as a second-class core subject when compared with mathematics and literacy. Science instruction is still fighting a losing battle to become a daily priority in the traditional elementary classroom. Science enthusiasts and advocates such as NSTA (2002) “supported the notion that inquiry science must be a basic in the daily curriculum of every elementary student at every grade level" (para. 1).

According to the principles of learning outlined in the National Research Council (2000) report,

> To develop competence in an area of inquiry, students must (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application. (p. 2)

With this new way of teaching and learning science, students retain new facts, ideas, concepts and deepen their understanding of scientific topics. When students are not given the opportunity for daily science instruction throughout their kindergarten through twelfth grade education, they might not develop a true proficiency of science standards. Osborne (2014) explained, "seeing science as a set of practices has shown that theory development, cognitive reasoning, and testing are components of a larger ensemble of activities" (p. 54). Smith, Best, Stubbs, Johnston, and Archibald (2000) discovered that when teachers focus on core scientific concepts and theories as an ongoing daily practice throughout their elementary years, they will demonstrate a deeper comprehension of science phenomenon when compared with student outcomes of students not exposed to this structure for science instruction. Science enthusiasts caution elementary educators to explore best practices that increase the frequency and consistency of science instruction so that students are given daily instructional time to engage in science lessons and activities to increase their standards proficiency as they progress through each passing grade and curriculum becomes more complex (Osborne, 2014).

Instructional Time (Weekly Block Frequency and Duration)

Exceptional elementary science education is indispensable for developing a solid foundation of science education to carry over into students' secondary schooling (Trygstad, Smith, Banilower, & Nelson, 2013). At the elementary level, teachers can instill a love and interest of learning the wonders of science and provide the avenues for fervor and passion for science that continues throughout their educational career and lifetime (Trygstad et al., 2013). This initiation to science phenomenon is critical for college and career readiness so that learners are knowledgeable and have the proper skills for trades and careers involving science concepts (Trygstad et al., 2013).

Science interests and inquiry begins informally before students step foot in formal education. Children are born with a curiosity about the world around them; their instinct for using age-appropriate inquiry skills to engage in their own forms of investigation, experiments, questioning, and problem-solving is how curiosity foundational skills are developed (Trygstad et al., 2013). Experts in elementary education identify this curiosity and utilize it to increase children's interest, knowledge of concepts, and pedagogical skills in engineering, technology, and earth science (Trygstad et al., 2013). Elementary science supporters focus their efforts on raising awareness in educational leaders of how necessary it is to equip students with scientific proficiency to have a reasonable chance at competing for careers and trades and add value to the scientific and technical industries (Trygstad et al., 2013). Science education is still struggling to make its daily presence in the education classroom due to the priority focus on mathematics and literacy instruction

(Trygstad et al., 2013). Many elementary teachers do not receive adequate professional learning to gain the confidence needed to teach science (Trygstad et al., 2013).

During their elementary years, students are unpretentiously inquisitive; therefore, the inquiry-based, hands-on platform used to engage students in science affords them opportunities with a student-centered cure subject. Students are immersed in exploration and discovery to equip them with knowledge and skills necessary in secondary education and college or careers post-graduation (Trygstad et al., 2013). Science is an active and engaging subject that captures young minds and is a critical foundational component of education for all students.

When children are exposed to the phenomenon of science, it instills a love of inquiry learning and builds the foundation for problem-solving skills that nurtures a lifelong interest in nature. Students who study science early in life develop into adults who are better prepared and more knowledgeable about scientific topics and issues that impact society and the economy. The Geological Society of America states, "Prominent issues facing us include land use and development, availability of energy and mineral resources, water resources and quality, preservation of wetlands, erosion, waste management, pollution remediation and geological hazards" (Cook, n.d., para. 3). When students are aware of the aforementioned topics, they may provide a wealth of skill and knowledge needed to remedy our world of such difficulties as adults. Many significant careers such as medicine, environmental advocacy, researchers, or engineering will require an efficacious foundation, knowledge, and pedagogical skills of science (Cook, n.d.).

According to Albone (1993), “science is a diligently human, intensely creative enterprise. Science influences our lives and presents society with immense opportunities and challenges” (para. 5). If educators want students to take job and career opportunities and meet challenges in science, they must create a district culture that supports the idea that students must be taught science at the elementary level and continue to do so through the secondary level (Cook, n.d.). Secondary educators must regularly teach and assess students on various science standards and topics, so it is imperative that elementary teachers prepare students for the progressing complexity by equipping them with foundational skills and content knowledge. It is unfair and frustrating for students to be expected to comprehend the complexities of biology and chemistry if they were never given a foundation of these scientific phenomena at the elementary level (Cook, n.d.).

Impact on Students

Interest in student engagement, proficiency, and skills in scientific content is beginning to increase. The collection of essential standards outcomes, lesson components, and scientific topics are now being explored, measured, and analyzed on state assessments. Data on invaluable questions, such as if student knowledge of science concepts and topics improved, if their ability to reason, problem-solve and think scientifically improved, or if their mastery and level of proficiency of science improved due to a specific instructional model or teaching type are being explored (Levy et al., 2008).

Furthermore, educational experts and advocates for science education have also identified issues that directly impact the teaching and learning of science. These findings are critical to a teacher’s ability to be prepared to deliver engaging and knowledgeable lessons and activities and students' abilities to relate to and retain the information presented in their lessons and activities (Levy et al., 2008) Researchers are beginning to gather and analyze data regarding student interest, engagement, fervor, problem solving processes, collaborative opportunities, and their long-term interest in STEM courses and activities throughout their educational career (Levy et al., 2008).

Collaboration and Student Achievement

Although educational experts could argue that collaboration positively impacts teaching and student outcomes, sparse research data supports this claim. The core supposition is that when teachers collaborate, it increases their knowledge and pedagogical skill to deliver more effective lessons and activities, which in turn positively impacts student achievement outcomes; however, these findings do not disentangle whether efficacy is developed through collaborative practices or some other factor (Goddard, Hoy, & Woolfolk-Hoy, 2000). However, Goddard et al. (2007) have found a statistically significant connection between student achievement and educator collaboration. Data from a survey of over 400 teachers were analyzed to determine whether school-level collaboration directly impacted fourth grade student achievement outcomes on mandatory mathematics and literacy state assessments. Utilizing hierarchical linear modeling with 47 elementary schools, Goddard et al. (2000) ascertained that teacher collaboration was a significant predictor of student achievement, even when controlling for students and other school influences.

Although Goddard et al., (2007) data analysis provides compelling evidence, teachers were posed with only five broad questions. Hence, the authors did not focus on nuances of interprofessional interactions or daily behaviors that comprise collaboration

(Levy et al., 2008). The results from Goddard et al. (2007) encouraged educators to develop a co-teaching instructional model to increase support and collaboration between specialists and generalists. The stronger the communication between specialists and generalists, the more effective the instructional practices, which positively impact student outcomes. Albeit there were no other schools that participated in the comparison, student cohorts in the collaborative instructional models displayed significantly more academic growth in literacy and mathematics on the Metropolitan Achievement Test (Goddard et al., 2007). Whereas research and empirical support for the idea that educator collaboration and student achievement are directly related is in its infancy, the initiatory discoveries are auspicious.

Collaboration in Professional Development

Transformative professional development with a priority focus being on collaboration can potentially indirectly improve student outcomes. This paradigm switch for educational leaders has been linked with increased teacher effectiveness (Ashton & Webb, 1986), instructional risk-taking, job satisfaction (Brownell, Yeager, Rennells, & Riley, 1997), and trust (Tschannen-Moran et al., 2001). Interprofessional collaboration between English speakers of other languages (ESOL) and classroom teachers has been linked to professional growth in areas of reflection, inventiveness, and even vigor (Davison & Miller, 2006). Collaborative learning cultures are a growing practice in education.

Hindin (2007) facilitated a study exploring the collaborative relationship between language arts teacher generalists, reading generalists, and special educators. Hindin unveiled that although difficulties with communication and collaboration may arise, the benefits outweigh the risks because teachers were able to share their content knowledge, pedagogical skills, support each other through observations and reflective feedback, model instruction, and engage in meaningful discussion about what is effective and what needs revision to meet the various needs of all learners. This teacher-centered collaborative learning community does not demand that the learning team share, or team teach students (Hindin, 2007). Collaboration involving educators in diverse roles who share, and delegate instructional responsibilities may find great difficulty in meeting for formal instructional training or session if it is not a mandatory requirement from the district or building leaders.

Barriers to Collaboration

Although teacher collaboration can strengthen teaching and positively impact student outcomes, the practice is challenged by many complications. Historically, teaching has developed a reputation for being a lonely and isolated profession (Fullan & & Hargreaves, 1991). Lortie (1975) used the metaphor of the “egg crate” to describe the daily function of classroom teachers being confined to their classrooms during the day. Little (1990) emphasized the egalitarian standard, which decrees that all staff has equivalent prestige. Educators, especially teachers, have continued to grow accustomed to the self-sufficiency, independence, deregulation, and disinvolvement afforded by staying in their separate classrooms (Little, 1990). Some teachers are apprehensive about ongoing collaboration for fear of losing autonomy to make instructional decisions for the immediate needs of the students in their individual classrooms (Little, 1990). Teachers are concerned that when receiving best practice and reflective feedback, they might be placed under a microscope by learning coaches and building leaders and be forced to implement systemic interventions and lessons that would decrease the likelihood of utilizing authentic lessons and assessments (Little, 1990).

Awareness of these concerns may cause professional development and training that is bereft of meaningful collaboration, communication, and reflective feedback that would strengthen teaching and learning. Friend and Cook (2017) identify three barriers to effective school collaboration: school structure, professional socialization, and pragmatics. A rudimentary practice is to explore how the structure of a school and the structure of each individual classroom can promote a culture of isolation and more teacher autonomy. Friend and Cook (2013) explained how directive methods utilized with student interactions might reflect staff interactions. Professional acculturation and socialization are more ineradicable because educators are conditioned to work independently at the preservice stages of their profession (Friend & Cook, 2017). During their first years of teaching, educators assimilate into cultures that value and support autonomy and self-sufficiency (Ashton & Webb, 1986; Little, 1990). Another critical pragmatic issue teachers face is scheduling time allotments for teachers across grade levels or similar core subjects to collaborate and meet regularly. When teachers are asked to collaborate with support staff, special education teachers, and ESOL teachers, these pragmatic issues may be overstated when schedulers must coordinate divergent schedules, time commitments, and contractual verbiage (Friend & Cook, 2017). Teachers already struggle with time management of their various duties, so adding one more demand to their already strained schedule could prove more stressful than beneficial if it is not structured in a way that the benefits of collaboration outweigh the risks of building the time into the schedule.

Role Ambiguity and Power

This section includes a description of each of the seven roles identified by science specialists. Each of the seven roles will include a description of how the specialists are utilized in the structure. A summary of how educational leaders can effectively determine which role for the science teaching specialist would best fit the needs of their staff and students is also addressed.

Table 1

Specialist Roles Require Multiple Tasks and Responsibilities

Specialist Role	Description
Resourcing	Science Specialists explore and build resources for teaching science, such as units of work, Primary Connections (PC) (Australian Academy of Science, 2015), or preparing kits.
Coaching	Science Specialists present professional learning sessions to a team of teachers or to the whole school in the form of discussing science content, pedagogies of science teaching, or involving teachers in curriculum and lesson planning.
Time release	This is a traditional specialist role in which Science Specialists planned, developed, and delivered the science unit to the students by providing time relief for classroom teachers.
Modeling	Science Specialists take the science class with teacher observing in the classroom.
Team teaching	Teacher takes the science lessons with support and assistance from the Science Specialist in the classroom or vice versa.
Peer observation	Teacher teaches the science class with Science Specialist observing in the classroom.
Mentoring	Teacher takes the teaching of science, supported by conversations with Science Specialist outside the classroom.
Independent teaching	Teacher plans and delivers science in the classroom independently.

Note. Adapted from "The Changing Roles of Science Specialists during a Capacity Building Program for Primary School Science," by S. Herbert, L. Xu, and L. Kelly, 2017, the Australian Journal of teacher Education, 42(3), pp. 5-6. http://dx.doi.org/10.14221/ajte.2017v42n3.1

Defining specialists' roles is intended to support comprehending the nature of the distinctiveness of science specialist roles as perceived and experienced by educators employed as science specialists (Herbert et al., 2017). However, it is important to emphasize that the roles asserted by the science specialists change over time and across buildings and districts as part of the capacity-building process (Herbert et al., 2017). Role modifications were strongly influenced and constrained by the local school context in which science specialists were employed.

Summary

The literature review conveyed that elementary teachers are not as prepared to teach science and that the emphasis on their teaching is not focused on the subject. The review also revealed that the science specialist model is somewhat more successful in the intermediate grades of elementary schools and that more hands-on, critical thinking projects and activities are used. Chapter 3 provides the research design, selection of participants, instruments used, and other essential components of this study.

Chapter 3

Methods

This chapter begins with the description of the research design, rationale, and paradigm for the overall study. The researcher explains the naturalistic qualitative interviewing approach used for the study. The 24 questions that guided the interview process are included. The qualitative components include a description of the research design, participant selection, instruments, data collection procedures, data analysis and synthesis, reliability and trustworthiness, researcher's role, and limitations.

Research Design

This study involved the utilization of one of the key naturalistic research methods, in-depth qualitative interviewing, to talk to professionals who have knowledge of and experience with the problem of interest, the underrepresentation of science in the elementary classroom and teacher preparatory courses and training. More specifically, the researcher implemented a responsive interview approach, which Rubin and Rubin (2012) said is based on strategically choosing people to converse with who are knowledgeable, listening to what they have to say, and asking new and follow up questions based on answers interviewees provide (Rubin & Rubin, 2012). Responsive interviewing is a specific variety of qualitative interviewing that emphasizes flexibility of design and expects the interviewer to change questions or ask follow-up questions in response to new knowledge or perceptions gained during the interview. Responsive interviewing accepts and adjusts to the personalities of both conversational partners, the interviewer and the interviewee. The responsive interviewing model allows the researcher to assume that interviewee's perceptions and experiences are true for them and that by sharing their experiences, the researcher can enter the interviewee's world and comprehend their thinking on a deeper level (Rubin & Rubin, 2012). The researcher's role is to gather narratives, descriptions, and interpretations from an array of conversational partners and put them together in a reasoned way that re-creates a culture or describes a process, set of events, or experience in a way that participants and readers would recognize and relate to as being real (Rubin & Rubin, 2012).

The study conducted would be described by Rubin & Rubin (2012) as interpretive constructionist because interviewee's meanings and understandings of their experience with the teaching and learning of elementary science at their particular school building are so unique to each educator's experience; each educator or group of educators may see and interpret reality through their own lenses; therefore, understanding is subjective. The goal of interpretive constructionists interviewing models is to utilize the qualitative data that is gathered to describe a particular event, process, or culture from the perspective of the participants. This model specifies conditions under which themes seem to hold, it is interested in contending and overlapping versions of reality, so many truths are possible. The description and analysis process foster an understanding of political, social, and cultural practices and processes that may be relevant to theory or may be the basis of a proposed action (Rubin & Rubin, 2012). This process directly aligns with the researcher's purpose of determining if elementary science instruction would be better served with a departmentalized, specialist instructor approach rather than a traditional classroom teacher approach.

The rationale for using a qualitative research approach is to produce an explanation for science teachers' perceptions of professional development and training, and teaching structures and strategies at the elementary level. The researcher engaged participants in face-to-face, telephone, or online media interviews. Participants were asked a series of open-ended questions concerning their perception of the preparation that elementary teachers of science are offered at the district and building levels and how this preparation impacts the learning at their contrasting instructional models, departmentalized compared with traditional setting.

Due to the limits placed on classrooms because of the global pandemic, Coronavirus, using qualitative interview data was valuable. Districts were requiring strict limitations on visitors inside the building, which restricted the opportunity to observe the teaching and learning at each site. The researcher maintained control over the line of questioning by asking participants to provide historical information, as suggested by Creswell and Creswell (2018). The interviewer and interviewees are also afforded the choice of platform to conduct the interview. With the need to maintain social distancing, web-based, email, or phone interviews may be utilized for safety precautions.

> Phenomenology is a research approach. A phenomenological study describes the meanings that several individuals have of experiencing a single phenomenon. The purpose of a phenomenological study is to reduce individual experiences of such phenomenon to a description of the basic "essence" of that experience, by creating a composite description of that experience for all of the participants. (Creswell & Creswell, 2018, pp.120-121)

"In a broader sense, phenomenology as a school of philosophical thought underpins all qualitative research, because of its interest in understanding and representing the subjective experience of participants" (Creswell & Creswell, 2018, p.135). Phenomenology uses multiple sources of data and data collection methods, and it often combines both qualitative and quantitative research approaches (Creswell 2007, 2009; Gass, Mackey & Ross-Feldman 2005).

The researcher chose to conduct the investigation through a phenomenological lens based on the study requiring elementary educators to share their perceptions of the teaching and learning associated with elementary science as a whole. The researcher did not include a quantitative component to the study due to the impact of the Coronavirus and the school shut down; students were unable to participate in states assessments for the 2019-2020 school year, so no assessment data was available to include. Creswell, (2009) noted that phenomenological research refers perceptions of events rather than how those events may exist (2009).

Setting

This qualitative study was conducted in a large, urban school district in the Midwest. The district was selected in part because of its high incidence of poverty which could reveal teacher perceptions about science teaching that could be different than those in districts with less poverty. The district also allows teachers the flexibility to choose teaching structures within each school with which they are more comfortable and confident that subject delivery and student achievement can benefit.

Selection of Participants

The targeted sample selected for the investigation was composed of two separate subgroups. The first subgroup selected included elementary level teachers of science in a large urban school district employed in buildings that departmentalize for science instruction for Grades 3-5. The second subgroup selected included elementary level teachers of science in the same district who are employed in buildings that implement a self-contained approach to science instruction. Each group was asked to participate in an interview addressing their perceptions of the classroom structures and strategies as well as the professional development and training for science education provided by their district, buildings, and individual classrooms. Participants for the interview were selected based on the criterion of the structure for science instruction at their building.

Instrument

The instrument used in this qualitative study was an interview protocol. The 24-question interview consisted of a series of open-ended questions of third through fifth-grade teachers of science to gain deeper insight into the teaching and learning practices for science instruction that are implemented at their schools. Due to the Coronavirus pandemic and the need to practice social distancing, interviewees were afforded the option of a face-to-face, Microsoft Teams, email, or telephone interview.

The interview questions were written to gather data on the thoughts, feelings, perspectives, and experiences of elementary teachers of science. The researcher also questioned participants regarding their perceptions of how their teaching practices have transformed or been altered due to the impact of the Coronavirus pandemic and the mandates for social distancing, masking, and sanitizing. The following interview questions were developed for the investigation. Interview questions are aligned with each of the three research questions:

Aligned with RQ1. What are teachers' perceptions of the effectiveness of science instruction in self-contained or departmentalized structure? The following twelve interview questions were written to address teacher perceptions of science instruction.

1. Please describe your role in the science classroom (Science teaching specialist, regular education classroom teacher etc.)
2. What science curriculum is implemented in your building?
3. What resources and materials are provided with the curriculum? Follow up: How much do you spend on out-of-pocket expenses to purchase additional resources and materials annually?
4. How often must you independently research and locate supplemental curriculum and resources to deliver quality instruction?
5. How much time is spent weekly on science preparation, planning, and instruction?
6. How often are students engaged in hands-on experiences and investigations? How often are students required to complete projects and labs to show their proficiency towards science standards?
7. Please describe a typical science lesson/activity/project in your classroom with respect to student engagement, inquiry, collaboration, and problem-solving. (Teacher's role, students' role, support staff's role)
8. What types of assessments are students given to monitor effectiveness of lessons and activities towards standards proficiency? (obtrusive, intrusive, formative, summative, observation etc.)
9. How do you use data to drive your instructional decisions?
10. Please describe any authentic, teacher-created assessments you have developed or opportunities you have created to differentiate instruction and accommodate the needs of various learning styles and levels for students.

11. Please describe classroom support available to students during science instruction. (ESOL, SPED, Categorical paraeducators etc.)
12. How often do you utilize district assessments to monitor student achievement?

Aligned with RQ2. What are teachers' perceptions of the levels of training provided for science teaching in self-contained versus departmentalized structures? The following seven interview questions were written to address teacher perceptions of professional development.

1. What college preparation courses, including and beyond your bachelor's degree, have you taken to strengthen your knowledge and pedagogical skills to deliver effective and engaging science instruction?
2. Please describe the professional development or training experience offered at the district level, building level, and grade level? (Time allotment, resources, materials, presenters etc.)
3. What are your perceptions of the professional development and training offered for teachers of science at the district level, building level, and grade level?
4. Please describe what a collaborative planning session consists of at the district level, building level, and grade level? (Time allotment, resources, materials, curriculum, members etc.)
5. What are your perceptions of the collaborative planning opportunities offered for elementary teachers of science at the district level, building level, and grade level?

6. How do you utilize the district Instructional Unit Guide to guide your collaboration and planning?
7. How many days and minutes of science instruction are students provided weekly?

Aligned with RQ3. What are teachers' perceptions of science teaching during the COVID-19 challenges in schools? The following five interview questions were written to address teacher perceptions of the impact that the Coronavirus pandemic and the mandatory shutdown had on science instruction.

1. How did the mandatory COVID-19 shut down impact science instruction? (Instructional time, lessons/activities, assessments, grading, support staff)
2. Please describe the professional development and training for science provided to teachers during the mandatory COVID-19 shut down at the district level, building level, grade level?
3. How was planning and collaboration continued during the mandatory COVID-19 shutdown?
4. How does science teaching and learning differ between My School Remote (MSR)(online) and face-to-face classrooms?
5. How has the mandatory COVID-19 shutdown and MSR option impacted your teaching practices moving forward?

Data Collection Procedures

The researcher employed a qualitative methodology of data collection and analysis described by Lunenburg & Irby (2008). Approval from Baker University and the cooperating school district are found in Appendices A and B respectively. Third through fifth grade elementary teachers of science participated in a face-to-face, email, Microsoft Teams, or telephone interview to share their perceptions of the teaching and learning at their school, and the effectiveness of each structure on student engagement and achievement. The purpose of conducting interviews with elementary teachers of science is to get a deeper and more honest insight into why teachers at each site hold the perceptions about the structure for teaching and learning science that is implemented at their building. The focus is on how effective the professional training is for preparing teachers to explicitly engage students in science curriculum and activities, and the effect it has on student engagement.

The researcher engaged participants in questions to gain insight and raise awareness into the online teaching strategies, engagement strategies, interaction, teacher and student observation and assessment, and communication strategies to compare best practices with student outcomes. The researcher is concerned with equating the beliefs, staff development, training, collaboration, parent involvement, and student achievement with the proficiency scores of teachers and learners of traditional, departmentalized, and online science instruction.

The qualitative method of data collection incorporated a face-to-face interviewing process with open-ended responses. The following steps were taken:

1. The researcher asked permission from the district’s Director of Research and Assessment to conduct the study and interview district employees. A brief explanation of the purpose of the study and the interviewing process was included in the email correspondence.

2. The researcher sent out email invitations to potential interviewees to schedule a time and venue for conducting the interview. The interviewees were afforded the opportunity to choose the venue to establish more trust and rapport during the interview. Interviewees were informed that the interview would be recorded to ensure fidelity of their responses and for the transcription phase of the study. Participants were sent a copy of the interview questions to prepare their responses, and received their interview transcript, once transcribed, via the email address provided.
3. The researcher prepared confidentiality waivers that include permission to record the interview. The waiver was signed, in person, prior to conducting the interview. The researcher placed the recording device in plain sight, notified the interviewee when the interview was to begin, and began reading the interview questions from the prepared document. The researcher and the interviewees were allowed to ask follow-up, probing, or clarifying questions during the interview to gain a better insight into the perceptions of the teaching and learning of science at their educational site. Interviews conducted through Microsoft Teams were recorded on the researcher's Surface Pro, and interviewees were made aware.
4. Teachers at two different sites, one departmentalized and one that implements a traditional approach to teaching science instruction, participated in an interview to determine if there were similarities or differences in teachers' perceptions of the professional development and trainings offered at their site. The second component of the qualitative component consisted of elementary

teachers of science at two schools participating in a face-to-face interview to share the teachers' perceptions of the effectiveness of the science program and structure implemented at their site for optimal student engagement and student state assessment preparation.

5. The researcher then conducted a second phase to combine the findings from the educational site to provide future researchers with an understanding of which approach to teaching science, departmentalized or traditional, provides better professional development and training, more engaging lessons, and yields more positive attitudes and academic outcomes regarding science for teachers and students. This can be described as phenomenological research.
6. Once all interviews were conducted and recorded, the researcher used an online software to transcribe interview responses. The researcher sent out a copy of the transcribed interview, via district email, to each of the participants to ensure the fidelity of the interview. There were no revisions to responses to influence the study outcome.

Data Analysis and Synthesis

As stated by Rubin and Rubin (2012), data analysis and synthesis are inclusive of the step-by-step process of taking raw data from interviews to "clear and convincing answers to your research question" (p.190). This analysis is supported by the detailed steps embedded in the design process, which ultimately allow for the development of a report that is significant in its investigation inspired by what each of the subjects shared (Rubin & Rubin, 2012). These steps included transcribing and summarizing each interview, coding the text, comparing coding across all transcripts, summarizing participant responses, and integrating the results of interviews to create a complete depiction (Rubin & Rubin, 2012).

After each interview, the questions and answers that participants provided were transcribed, without inaudible utterances, verbatim. The interviewer was intentional about ensuring that the audio and transcribed versions of the interview were indistinguishable. The researcher reviewed the audio version of the recorded interviews while reading the transcribed version of the interview. The researcher read each transcript a second time to begin the data analysis process, and address the three research questions, classroom teacher and specialist teacher interview data were analyzed separately.

After each interview was transcribed, the researcher conducted an initial coding of the text by finding and marking relevant concepts and themes in the transcripts. The Dedoose Research Analysis software package was used to upload and thoroughly analyze the files that contain the transcripts for each interview. Interview responses addressing the perceptions of intermediate-level elementary teachers of science regarding the preparation offered at their school for science instruction were compared with the interview responses addressing the perceptions educators have regarding the structure for teaching and learning science in their school. Similarities and differences were derived from these responses and grouped according to how positive or negative their perceptions were determined to be. Perceptual data regarding student outcomes were aligned with educator responses from each of the comparing schools to decide if the perceptions that educators at each school setting held, along with the difference in structure for instruction have an impact on student achievement outcomes and teacher effectiveness. Finally, perceptual data concerning the impact that coronavirus pandemic guidelines have had on instruction were compared with perceptions of science teaching and learning pre-pandemic.

Reliability and Trustworthiness

Assurance of analytic rigor such as steps taken to guard against selectivity in the use of data, triangulation, expert checking, member checking, and trustworthiness are explained. A detailed description of the strategies used for minimizing bias, and a validation of the results are presented. Since qualitative researchers do not use instruments with established metrics that require validity and reliability checks, it is pertinent to address how qualitative researchers establish that the research study's findings are credible, transferable, confirmable, and dependable. Credibility is how confident the qualitative researcher is in the truth of the research study's findings (Statistics Solutions, 2021). The researcher established credibility by involving the assistance of the district leader of research and assessment to gain approval to conduct the study by interviewing district teachers and an expert panel of peers to review and revise interview responses and assist with editing chapter components.

Transferability is how the qualitative researcher demonstrates that the research study's findings are applicable to other contexts (Statistics Solutions, 2021). In this case, "other contexts" can mean similar situations, similar populations, and similar phenomena. Qualitative researchers can use thick description to show that the investigation's findings can be applicable to other contexts, circumstances, and situations (Statistics Solutions, 2021). The qualitative phenomenological approach used in this study could be employed by future researchers who are interested in the exploration of quantitative data comparisons along with qualitative data analysis and comparisons of perceptions to decide a known phenomenon.

> Confirmability is the degree of neutrality in the research study's findings. In other words, this means that the findings are based on participants' responses and not any potential bias or personal motivations of the researcher. This involves ensuring that researcher bias does not skew the interpretation of what the research participants said to fit a certain narrative. To establish confirmability, qualitative researchers can provide an audit trail, which highlights every step of data analysis that was made to provide a rationale for the decisions made. This helps establish that the research study's findings accurately portray participants' responses. (Statistics Solutions, 2021, para. 4)

The qualitative data collection was transcribed through online software, and copies of the transcriptions were shared with interview participants prior to study defense to ensure that no responses were skewed to influence the research outcomes. The researcher kept confidential and accurate recordings and records of data collection and analysis procedures to compare with study results.

"Dependability is the extent that the study could be repeated by other researchers and that the findings would be consistent" (Statistics Solutions, 2021, para. 5). If another researcher "wanted to replicate your study, they should have enough information from your research report to do so and obtain similar findings as your study did" (Statistics Solutions, 2021, p. 5). The final research phase was to compare qualitative perceptive responses from each instructional setting to determine if there were similarities and differences between perceptions and instructional approaches and, if so, what variables could explain the strength or weakness of the relationship.

Researcher's Role

The researcher's role is stated in this section. The researcher is currently an elementary educator and is aware of possible bias in personal experiences with science education; however, the interviewer did not share any personal beliefs or experiences with science education with interview participants. Interview participants were aware of the interviewer's employment with the cooperating district, but no specifics were shared concerning the professional role or responsibilities. Interview participants were advised that their responses would be used to help gather data that could possibly raise awareness to support a potential science reform at the elementary level.

As the primary investigator, the researcher brought certain biases to the study. The researcher has been employed as an experienced educator for seven years in the district in which this study was conducted. The researcher's personal experience with the difficulty of adhering to the district pacing guide and science curriculum, was the reason for exploring the concerns about elementary science instruction. The researcher's concern with the focus from No Child Left Behind, Common Core, and the district strategic plan primarily focusing its efforts on mathematics and literacy proficiency, causing science instruction to oftentimes become neglected in the elementary classroom was the reason that the researcher was passionate about advocating for elementary science. The researcher's experiences as an elementary science teacher not only shaped the views and perspectives, but also expanded the aptitude for recognizing, appreciating, developing, understanding, and delivering effective science lessons and instructions.

Elementary students are required to meet science proficiency standards, and elementary teachers are responsible for preparing students for secondary level science instruction; therefore, more preparation in the elementary classroom is necessary toward helping students meet proficiency. Conversations among elementary educators have raised the concern for the professional development and training and collaboration provided at the district and building level for preparing teachers to become competent and effective standards-based science instructors, and some buildings have piloted a departmentalized structure for science instruction to address these concerns. The researcher's role was to gather and analyze qualitative data to determine similarities and differences in students' classroom engagement and outcomes depending on the structure of the science instruction, departmentalized versus integrated.

The researcher explained her role to the interview participants to encourage honesty, open dialogue, to establish a professional yet personable rapport to help the participants gain an understanding of the type of conversation desired for the study (Rubin & Rubin, 2012). The objective of the researcher's role in the study and the responsive interviewing approach was to allow the researcher to guide the respondents' thought process and responses to evoke complete responses without influencing what the responses might be, so that "encouraging conversation, reacting to what interviewees say, and asking detailed questions to follow up initial answers" (Rubin & Rubin, 2012, p. 72). The researcher was cautious of potential personal bias. The researcher is an elementary classroom teacher of science who believes that science is underrepresented in the elementary classroom. This belief is what the basis of the study was built on, and therefore, the interviewer did not engage in any conversation before, during, or after the interview process concerning science education. Interview participants were not made aware of the researcher's personal stance concerning elementary science education from the staff or student perspective.

Limitations

The limitations of a study are not under the control of the researcher. Limitations are factors that may have an effect on the interpretation of the findings or on the generalization of the results. Limitations may arise from the methodology, data, or method of analysis (Lunenburg & Irby, 2008). The study has the following limitations:

1. Many variables outside of the researcher's control could have impacted teachers' perceptions of student outcomes. These variables could include student engagement during classroom instruction, classroom management, students that require accommodations and modifications due to English Speakers of Other Languages (ESOL) or Special Education (SPED), or how often students are exposed to science material and effectiveness (preservice and ongoing preparation) of educators delivering instruction.
2. When asked to participate, not all intermediate elementary educators in the district may be interested in the interviewing process.
3. Study participants may not have responded with complete comfort in being forthcoming answers or may not have answered each open-ended question completely.
4. There are no records to determine what professional development, training, and collaboration were provided at the district and building levels, and which educators participated.

5. Interviewees may have changed their responses to align with what they believe the researcher perceives or expects as the outcome.
6. The researcher does not have data from firsthand observations of the effectiveness of the teaching and learning of science instruction for the educators who participated in the interview process.
7. The researcher does not have student assessment data to support the experience that teachers have with delivering standards-based science instruction and assessment in the classroom.

Summary

Chapter 3 provided an overview and explanation of the research methodology, The qualitative components include a description of the research design, participant selection, instruments, data collection procedures, data analysis and synthesis, reliability and trustworthiness, researcher's role, and limitations that may affect the results of the study were all explained. The researcher used a naturalistic research method, responsive interviewing, which accepts and adjusts to the personalities of both conversational partners, the interviewer and the interviewee, while assuming that the interviewee's perceptions and experiences are true for them. Presented in Chapter 4 are the results from the interview process, the transcription information from the interview responses, and the findings after comparing the perceptions of elementary science educators employed in two diverse academic settings.

Chapter 4

Results

Chapter 4 provides the reader with an explanation of the results of the study. The purpose of the study was to explore the perceptions of elementary teachers of science to gain insight into the structures for teaching and learning science, and which structure is more effective for student engagement and teacher preparation. To examine the research questions, the researcher conducted a qualitative study requiring interviews of certified elementary teachers in the largest school district in the midwestern United States. Due to the Coronavirus pandemic guidelines and the need to practice social distance, wear masks, and sanitize, visitors were not allowed in school buildings; therefore, interview participants were given the option to answer interview questions face-to-face at a safe location or via email correspondence, telephone conversation, or Microsoft teams. Three interviewees chose to interview face-to-face, two interviewees chose to answer questions through email communication, and one interview was conducted via Microsoft teams meeting. To protect the anonymity of the district, buildings, and participants, pseudonyms were used in place of actual names.

Table 2

Interview Respondent Numbers, Grade Taught, and Teaching Structure

Respondent #	Grade Taught	Teaching Structure
Respondent 1	Specialist	Departmentalized
Respondent 2	Third	Traditional
Respondent 3	Third	Traditional
Respondent 4	Fourth	Traditional
Respondent 5	Fourth	Online
Respondent 6	Fifth	Online

The results of the study are separated and described according to each of the three research questions. The findings for each research question are explained according to each unique set of interview questions that directly align. The first section below is the findings from interview questions one through eight, which answer research question one.

Finding 1: Science instruction in self-contained classrooms compared with departmentalized classrooms. The results from finding 1 address research question 1 of the study. RQ1 asked elementary teachers of science to share their perceptions of the effectiveness of science instruction in self-contained or departmentalized structure? The following section describes the responses that the interview participants shared when asked the eleven questions focused on the teaching and learning of science. When the interviewer asked participants how many days or hours of science are provided to students weekly, each teacher explained that there are inconsistencies in the frequency and duration of the science block. Respondent 5 asserted, "well, it all depends on the quarter because some quarters have standards and others do not. When we do have them [science standards], I spend, roughly 90 minutes a week, maybe." Respondent 4 shared, "science is shared time with social studies, but if there is an actual standard we put in a little more effort." The respondent continued to add, "science gets the back burner if there are other things that we need to get done for our class, then science is the subject that usually gets cut." The district allocates two, shared 45-minute instructional blocks that are shared between science and social studies each week. Teachers are given autonomy to decide individually or with their collaborative group to plan how to utilize the two blocks weekly. Some grade level teams choose to use both blocks for either science or social studies until the required standard is addressed, while others choose to dedicated one block each week for science and one for social studies to ensure students are receiving instruction in both subject areas.

The researcher then asked participants to discuss the research-based curriculum, resources, and materials that are provided for science instruction. The interviewees simultaneously responded that there is no science curriculum provided by the district, and that the materials that are supplied are limited. Teachers are being tasked with purchasing science materials with their own money, which can get costly when considering annual budget dollars. Respondent 4 enjoyed having students engage in hands-on experiences and shared

> The better science you want to do, the more out of pocket expenses you will have. We have tubs in the library that has some things we can use, but it is going to come out of your pocket if you want to do some cool stuff.

Respondent 3 provided, “To the best of my knowledge there is no curriculum per se.”. The district does not consider science a priority focus, therefore, science is taught depending on the interests and instructional pedagogy that each classroom teacher brings to their classrooms. Respondent 2 expressed their enjoyment of science and shared her experience with researching science curriculum, lessons, and activities with her grade level group and shared how much out-of-pocket expenses are accrued when independently providing engaging science instruction.

> I used Mystery science last year and this year. I recently found another website that has excellent experiments to get the students engaged. It is called Generation Genius, this costs $159 for a school year. Mystery science will not be offering a classroom license next year, so I won't be able to do it. In addition to the $159 for the membership to the Generation Genius, I spend at least $300 of my own money.

The science teaching specialist (Respondent 1) highlighted her experience with trying to find funding and budget allocations for science through conversations with her building administrator or writing grants to supply materials for specific lessons and activities. “There is no curriculum, so we use Multi-Tiered System of Support (MTSS) strategies (5E model, AVID strategies). One grade level team pulls things from FOSS, but most come from Steve Spangler, but those are not research based curriculums” (Respondent 1). She continued, “I have spent up to $1,000 annually. I beg my principals and ask for grants. Title 1 buildings are better at supporting science funding, but when you do not have the building leader’s support, students go without.” Teachers agreed that it feels great to be given autonomy to choose the curriculum, lessons, activities, resources, and materials, but assert, that it also makes it difficult to provide a plethora of activities without the district and building support for funding. Teachers are normally given scripted curriculum to implement mathematics and ELA instruction, so science allows them the freedom to differentiate and tailor instruction more for their students' preferences. Respondent 4 offered a suggestion to elementary science reform that was suggested by her building principal, "The principal suggested once before, that we should drop one of our specials and then hire an actual science teacher instead because they could teach it well. And then the kids would get better quality instruction." Teachers said they believe that having an actual science teacher, who teaches science separate from core subjects would allow students quality experiences and take the burden of purchasing and preparing science lessons without district support, from the classroom teachers.

The researcher discovered opposing views when teachers were asked to share their experience and perceptions of how often students were able to engage in hands-on experiments, investigations, and projects. On one side, teachers believed that students were unable to engage in hands-on lessons due to COVID-19 guidelines and limits of online learning platforms. On the other side, teachers found creative ways to allow students hands-on opportunities by purchasing materials for their face-to-face classes or by having students ask for parental consent to use items found around their homes. Respondent 4 added that she was saddened by the lack of focus on science instruction and offers, "It [science] is not a priority. It's sad. We don't get a lot of hands on, and the kids love it." Respondent 5 stressed:

> Online usually consists of posing a question to interest students in inquiry and see what they already know about the topic with a K-W-L chart. Then they [students]

would do research of some sort or watch a video in response to the initial question that was posed.

Teachers who were more creative in their planning for hands-on experiments and investigations seemed to be represented by Respondent 2, who said

> We start a lesson off by going over some vocabulary that they will be hearing in the lesson for the week. We move on to watch a video to explain the concept for the week. Next, I break my students up into groups to work on the experiment part of the lesson. When they have finished the experiment or hands on activity, they either answer questions over the experiment or write a reflection answer questions about it to check for understanding.

Respondent 2 noted, “I don't use the districts assessments. The lessons are boring and non-engaging for my students.” Interview participants responded on opposite ends of the spectrum regarding how data are used to drive instructional and planning decisions. On one end, teachers felt that there are not many opportunities to teach science; therefore, there are not many opportunities to gather useful data. Respondent 4 offered, “in other subjects when students do not get it, you repeat things and evaluate that maybe you did not teach it your best or you try another strategy, but science is not a priority in the district, so we do not treat it in the same way when students do not master the standard.” Respondent 5 offered that:

> I feel like in other subjects there are a lot more opportunities to gather data. I can tailor my teaching to what the students understand and don’t understand, but in science I feel like there is almost a continuum that you have to follow, and even if

> students do not get it, you just expose them to the material and not really look for their concrete understanding.

Respondent 3 shared that, "if students did not fully grasp a scientific process, I will reteach using a different experiment so attempt and solidify the scientific principal or idea in the student's brain." Respondent 1 suggested that having prior knowledge of mathematics and ELA proficiency assists with her scaffolding and support for each individual student.

> I know who has an IEP, so I use knowledge of reading to scaffold and group them accordingly. Science should not be negated because of lack of reading skills (use ELA reading strategies and never independent reading). Not being able to read, access, or comprehend text should not stop students from learning science.

District formative and summative assessments are not provided for science instruction and building leaders do not provide instructional support staff during science blocks, so classroom teacher have found innovative ways of creating opportunities for authentic assessments to monitor student proficiency in science standards. Teachers have also discovered strategic ways to group students that struggle during instruction, so that they are able to participate without the burden on learning difficulties. Respondent 4 shared her attempt at supporting academic needs during science instruction, "the only thing I can think of is putting a higher learner with a lower learner. Just giving extra help and support to those that are lower." Respondent 5 suggested differentiating the lesson or activity, "I have done standard differentiation for things they have been required to read and I have given them sentence starters, but nothing tailored exclusively for science instruction." The following interviewee shared insights on having no district assessment and having to create his own due to having the autonomy to create authentic lessons and activities. Respondent 3 noted:

> For math and usually ELA I will utilize the district assessments for obtrusive assessments. ELA is not always aligned with where we are so sometimes, I need to make my own assessments from parts of pieces of the curriculum and/or district assessments. The state assessments are given too early and many of these students have not been taught the lessons they need to know to be successful.

Some of the difficulties with teaching elementary science during the 2020-2021 academic year can be answered due to the devastating impacts of the Coronavirus pandemic. The need for social distancing, stringent sanitation practices, bans on allowing students to work in small groups, and the mandatory online only decision, caused teachers to think deeply, research ideas, and develop plans that would make learning possible from home.

Finding 2: Science teacher professional development and training. The results from finding 2 answer research question two, "What are teachers' perceptions of the effectiveness of professional development in science instruction?" When asked to share their role in the classroom, only one interviewee responded who was considered a science specialist by definition. The other interview participants consider themselves regular education classroom teachers or generalists. The researcher was interested in college courses that were specific to science instruction completed beyond a bachelor's in elementary education, and the trend in the response was that classroom generalists do not have college preparatory courses beyond their bachelor's that are specific to science. Only the science specialist (Respondent 1) was able to respond, "Only for license renewal, provided during district professional development. I did not take any helpful college courses. My only science-based course was earth partnership class."

Participants were then asked to share their perceptions of the professional development and trainings offered for teachers of science at the district level, building level, and grade level concerning time allotment, materials, resources, and presenters. Every interviewee was adamant that there is no professional development or training provided for science; however, there are ongoing professional development and training sessions focused on mathematics and ELA. Respondent 3 noted:

> In my current district, I have had zero training in science; however, I have had extensive training in ELA and mathematics during professional development. The materials given during this time are always very well researched and a good reference. In my previous district, the science teachers met weekly to discuss everything from materials needed, lessons delivered or approaching and assessments of the standards.

Respondent 1, currently working as a science specialist and has experience as an MTSS facilitator or instructional coach shared:

> Friday learning lab as an MTSS facilitator was most beneficial at preparing me for teaching. I received no professional development or training for science. I used to attend middle school trainings, on district in-service days once or twice annually, but it was not very beneficial.

She went on to say,

> As an MTSS facilitator, I would receive materials to distribute, but never enough. I have done 'Donor's Choose' and won an Education Edge grant because there

> are not any curriculum, resources, or materials offered at the district or building level, even when I worked at a magnet school that specialized in STEM education.

The researcher also discovered a common thought among elementary teachers stating that science standards are often addressed by integrating them with ELA lessons and activities rather during the designated science block. Respondent 6 stated, “In my seven years [with the district] there were three sessions for ½ hour to an hour. At the school level, we get more if the instructional coach is more enthusiastic. [Science is usually] integrated into ELA.” Teachers held that professional development and training for science is best served with their teammates at the grade level as noted by Respondents 4, “We get more out of team collaboration than what has ever been provided by the district or the building. We just go off the standard and then after that, it is on us,” and Respondent 5, who stated, “I get more from my peers regarding science than I do at the district or building level.”

The researcher then asked the interview participants to describe what a collaborative planning session consists of and how the district curriculum guide (IUG) is used in the planning process. The responses were similar to that stated in the response from Respondent 1 in saying, “planning, looks at ELA IUG for writing standards, and uses the science standards to put them into our lessons. To be honest, I think I may have looked at it once or twice. We plan according to our curriculum targets and find experiments that will fulfill those needs and keep the students as fully engaged as possible.” In complete contrast to the other five interview participants, Respondent 6 stated,

> [IUG is] very handy for determining a 'skeleton,' 'roadmap,' but in depth, we look at standards and integrate with ELA standards. It takes a lot more prep than what is given from the district. My team even used NGSS standards to build lessons and activities.

The common similarity among all six interview participants was the fact that they agreed that mathematics and ELA instruction takes precedence over science education in the regular education classroom, therefore, PD, training and collaboration is rarely utilized to discuss or prepare teachers for science instruction. Science instruction is addressed if the teacher or team of teachers seeks out science lessons, activities, resources, and materials to address science specifically. More often than not, science standards are integrated into ELA instruction and addressed through reading and writing standards.

Finding 3: The impact of coronavirus on teaching and learning practices. The results from finding 3, address RQ3. Five interview questions were written to address teacher perceptions of the impact that the Coronavirus pandemic and the mandatory shut down had on science instruction. Interview responses concerning continued science instruction ranged from inability to teach science or to very limited in what lessons and activities were possible for students from home. Respondent 1 asserted that the shutdown changed the trajectory of science from inquiry to more ELA standards.

> COVID-19 makes it [science] so limited and repetitive, we have done lots of gardening because that is the only thing they are allowed to do. Now I feel like more of an ELA teacher because hands-on is not allowed. They [students] do text work, but the hands-on part has been removed, and gardening only happens

> because I have lots of tools and I sanitize them in between classes. Centers are not possible because materials would have to be shared and sanitized or the teacher would be required buy more supplies.

Respondent 4 shared his creative approach to continuing science instruction from home for the students who had parent permission to utilize materials that were available in their home.

> I did not take grades at all during the shutdown, and I did not teach science. When the weather was decent, I would have the kiddos go outside. We did an activity with the snow. I showed them a video of how fast things could freeze and then they chose one of the things to test how fast it could freeze when our windchill was below zero. I had to get parent permission and they had to bundle up, and some parents said no. The parents [who] participated with their child emailed the videos of the items that they let freeze and the amount of time it took to freeze, and then I shared the videos with the class online.

Interviewees unanimously agreed that the professional development and training provided by the district was not beneficial. The primary focus was on ELA, and they rarely met and collaborated with their planning team. The shutdown separated everyone from each other, but the district made weekly check-ins with families mandatory. There was no expectation to continue learning outside of a district prepared and distributed mathematics and ELA packet that was sent to all students via U.S. mail.

When the decision to resume school came and staff and students were welcomed back into buildings with stringent COVID-19 guidelines, buildings faced the dual tasks of finding ways to meet the needs of online and face-to-face learners simultaneously.

Respondent 5 shared about the almost depressive state of mind it put teachers in. "There was almost like a helplessness during the shutdown. There was like a mutual understanding that we really couldn't reach the students very well." Respondent 4 shared his thoughts on how the shutdown increased the absence of science in the elementary classroom. "Science was even less of a priority when we were at home. It was on our team if we wanted to do something." Most teachers reported that they did not participate in planning with teams nor did they address science standards during the mandatory shut down. The district shifted its priority focus to high school students and only maintained grades for students who were scheduled to graduate. Elementary teachers were told to freeze grades where they were when students were released for spring break.

The researcher was interested to know teachers' thoughts and opinions concerning the shifting back and forth from online to face-to-face at a moment's notice during the 2020 fall semester. All respondents agreed that learning and engagement is much more impactful when students learn in person. Respondent 3 commented:

> Face-to-face (F2F) allows for added hands on experiments, timely questions and engaged learning. I believe F2F engages the learner in a more social environment which assists in the learning. The more fun a student has the better memory of the lesson. My School Remote (MSR) while a choice is not very effective for young kids at all. I do not feel MSR should be allowed for grades below middle school due to the amount of engagement the younger students need.

Respondent 4 reflected that there was far better participation in person. Some just choose not to do it when teaching remotely. "Saves money when you are on remote, for the teacher because your lessons are what parents can provide or already have available at home." Although online learning is more cost efficient for the classroom teacher, engagement and inquiry opportunities can prove to be a struggle. Teachers share in the frustration of feeling extremely limited and nearing helplessness concerning students that chose not to participate; especially in homes that do not have strong parental supervision. Respondent 5 stated, "You [the teacher] are trying to use inquiry, but it is a lot harder. And students don't have something concrete because science is an abstract concept, you can't really scaffold it online." The science teaching specialist (Respondent 1) offered:

> I teach both [F2F and MSR], and because we can't do centers, there is not a lot different because there are too many restricts and limitations both ways. Lessons consist of trade book, fiction/non-fiction compare and contrast, and then they get to build or draw something related to the topic. At home, kids can use materials that are at home, but supervision and funding at home puts limits on what they are able to do and what they have.

Every educator agreed that experiencing online planning and teaching was frustrating; however, they also said they felt they gained more pedagogical skills regarding their teaching practices moving forward. Again, Respondent 5 said,

> Moving forward, I know how to utilize technology better for teaching and for science. It also helped me realize the significance of implementing hands on instruction and being able to scaffold and differentiate. I am also a little more confident in my teaching because I have had to endure the remote option, so when I do return to face-to-face teaching, I will be able to be more authentic for science.

Respondent 4 shared his perceptions of strengths developed in planning, and strengths gained in using home materials when parents allow, and students choose to actively participate. Respondent 4 reflected, “As far as remote goes, it has given me ideas on how to take advantage of the elements of weather. You [the teacher] can still do cool stuff, for those that are willing to participate.” Respondent 3 noted,

> I always keep an alternate plan in the back of my mind that will align with what I want to teach should I suddenly be forced to go MSR. I plan just like normal but then ask myself, how can I deliver this remote if need be and make or brace myself for any adaptations that might be required.

Concluding the Interviews

The researcher concluded the interview by asking all of the participants if there was anything they would like to share that was not asked during the interview. Each respondent shared a positive suggestion that could be considered when decision makers decide to reform elementary science education. Respondent 1 summarized it this way:

> Engagement is hard, some kids are even in the car or at the babysitters during school, and not at home. This year has been rough. Kids are not unable to participate because they do not know where supplies are or if they can use them, and kids get upset because they cannot participate. Parent participation varies. I hope we [the district] go back to normal. I am a 15-year veteran science teacher, and I now feel like a first-year teacher again. I spent more than ever to develop and create lessons and activities to accommodate COVID-19 and get creative with supplies and materials and funding. The only positive, in retrospect, was having one-to-one technology.

Two educators said they felt that the strongest and most impactful approach to science reform is for the district to shift their paradigm by making science a priority subject. They each suggested having a science teaching specialist in charge of science lessons and curriculum separate from the regular education classroom. Respondent 4 stated,

> I do remember in years past when they [the district] did send some type of curriculum, like some email-based training. If the district wants science to be taught well, they should be preparing teachers better, if they really want to take it seriously. They have formal math and ELA curriculum and planning guides available for teachers, so science should have the same prep. The best would be to bring in an actual science teacher, same as specials.

Overall, the conclusion can be drawn that science does not appear to be a priority in the district. Teachers do not feel they are given the necessary tools to deliver engaging lessons or sufficient time to collaborate and enhance their pedagogical skill in science.

Summary

Chapter 4 included a synthesis of the qualitative interview data gathered from six elementary teachers of science regarding their perceptions of elementary science in their district. Several common themes appeared in the perceptual responses that were provided, and the researcher was able to draw conclusions about teacher preparation, classroom strategies and struggles, and the impact that the Coronavirus pandemic had on science education during the 2020-2021 academic year. Overall, elementary teachers agreed that science is extremely underrepresented and not prioritized at the district level, so there could be so much gained from the addition of a science teaching specialist and departmentalized approach to science instruction for teacher development and preparation as well as for student proficiency and engagement outcomes.

Chapter 5 includes an overview of the problem, a recap of the purpose statement and the research questions, review of the study's methodology, major findings for the study and similar studies, findings related to the literature review and implications for future research. Concluding remarks are also included in Chapter 5.

Chapter 5

Interpretation and Recommendations

Chapter 5 is divided into several sections. The study summary includes the overview of the problem, the purpose statement and research questions, a review of the methodology and major findings. Findings that are related to the literature are discussed. The conclusions section includes implications for action, recommendations for future research, and concluding remarks provided from the researcher.

Study Summary

This qualitative study examined the teacher perceptions held by elementary teachers of science that implement the science specialist model as compared with buildings that implement a traditional self-contained structure. Elementary teachers are tasked with ensuring that students meet state and district proficiency levels for mathematics and ELA, so the focus is on these two core subjects. Science often is underrepresented or neglected due to the priority focus being placed on mastering mathematics and ELA standards (Banilower, et al., 2010). The study included teacher perceptions of preparation and professional development for science instruction and the impact COVID-19 had on science instruction. Teachers also shared insights about possible ways to remedy the issue of science being underrepresented in the elementary classroom.

Overview of the problem. Science instruction in the elementary grades is often diminished or not included. While this may be due to the emphasis on ELA and mathematics, there also seems to be little preparation or ongoing support of teachers for science instruction. The lack of adequate science instruction may have been impacted further by the COVID-19 pandemic and necessary closing of schools to face-to-face instruction.

Purpose statement and research questions. The purpose of the study was to gain a deeper understanding and insight concerning the teaching and learning of elementary science. The following three research questions were used to guide the study:

RQ1. What are teachers' perceptions of the effectiveness of science instruction in self-contained or departmentalized structure?

RQ2. What are teachers' perceptions of the levels of training provided for science teaching in self-contained versus departmentalized structures?

RQ3. What are teachers' perceptions of science teaching and learning during the COVID-19 changes in schools?

Review of the methodology. A qualitative research design was used for this study. Qualitative interpretive constructionist interview data were gathered. This method of data collection was selected to support the researcher's exploration into the perceptions and opinions of elementary educators concerning their experiences with learning and teaching science. The interpretive constructionist approach allowed the researcher to gain insight into teachers' perceptions concerning structure for delivering science instruction, the professional development and training provided, and perceptions regarding the effects of COVID-19 pandemic on science instruction. The researcher was able to provide various ways to conduct the interview process with respect to COVID-19 guidelines while ensuring that interviews were confidential. Data were recorded, transcribed, and analyzed using the Dedoose application tool.

Major findings. Several findings were uncovered in the interview data that allowed the researcher and provide the reader a deeper insight into the experiences and opinions of elementary science educators. The first major finding in the study was that elementary educators feel that science is underrepresented in the elementary classroom and is treated as a secondary subject in comparison to mathematics and ELA.

The second finding was that teachers perceive that they are not provided sufficient staff professional development, training, and collaborative opportunities to support science instruction.

The final major finding of the study was that COVID-19 and the mandatory shut down created a challenge of continuing science instruction due to the lack of staff development and planning and the lack of materials and participation when students were online. Some teachers suggested that science education would be better served if it were made a priority, and if purposeful planning were made available separate from ELA. Often, science standards are integrated with ELA, which can lessen the importance of science education as a separate entity.

Findings Related to the Literature

Prior to study completion, the researcher conducted a review of the current literature concerning elementary science education. The literature review addressed topics associated with elementary science dating back to the 1960s. The structures that have been implemented for science instruction have evolved throughout the history of education. Research suggests that to be considered effective, teachers must be skilled and knowledgeable in understanding science content, learner strengths, weaknesses and interests, and pedagogy strategies and designs, and be able to monitor students' science learning experiences, and how to utilize various assessments to gather data to guide their planning and teaching (Abell et al., 2008). These requirements are true for regular classroom teachers as well as science teaching specialists. Interviewees confirmed that science instruction is not only less effective in the self-contained instructional structure, but is reduced considerably.

Chaney (1995) and Goldhaber and Brewer (1997, 2000) shared that research results broadly support the belief that higher levels of teacher subject matter knowledge are directly connected to higher student achievement. Chaney (1995) and Goldhaber and Brewer (1997, 2000) also asserted that having a major or a graduate degree in a subject catalyzes a teacher's effectiveness and positively impacts student achievement. Ultimately, if teachers feel empowered to deliver quality instruction through preparation, they will deliver more engaging and effective lessons and activities toward student achievement (Chaney,1995; Goldhaber & Brewer, 1997, 2000). Eighty percent of states require demonstration of subject matter competence and aptitude for completing and obtaining an elementary school certificate, but most states do not stipulate what that means in terms of the content that teacher candidates should study, nor the clusters of courses they should take (NAP, 2007). Findings of this study indicated that, as the literature suggests, science instruction is reduced in the self-contained structure and that the perception by teachers of student achievement is diminished.

This is consistent with the findings of Yager 2020 which stated that science at the elementary level was considered a rarity until the middle of the twentieth century (Yager, 2020). Yager noted that science is not taught consistently because educational leaders have been pushing teachers to focus their efforts on mathematics and ELA proficiency.

The National Council for Accreditation of Teacher Education standards called for elementary preparation programs to attend to candidates' knowledge of science and technology, inquiry, science in personal and social perspectives, and the history and nature of science. Research finding 2 is consistent with the literature that the scientific knowledge of K-8 teachers is often vague, leaving teachers feeling ill prepared to deliver quality science instruction (NAP, 2007). This was verified by interviewees who reported little or no preparation to teach science. Influences likely to contribute to feeling ill prepared to deliver effective science instruction are narrowly focused preservice college preparatory courses, insufficient teacher professional development, and a credentialing process that requires little of prospective and current K-8 science teachers (NAP, 2007).

Finding 3 was that, due to the impact of the COVID-19 pandemic and the need for a mandatory shutdown of schools, teachers were only required to meet with students once weekly to assign ELA and mathematics lessons or activities and to answer questions that students or families may have had. Dillon et al. (2006) found that time spent in science instruction was greatly reduced when the emphasis on NCLB switched focus away from science. During the COVID-19 pandemic, teachers interviewed reported a similar shift in focus away from science instruction. While Goddard et al. (2007) found that science instruction increased when the science specialist model was implemented, results in this study indicated that science instruction almost disappeared during the COVID-19 pandemic except in the limited cases in which science specialists were involved. Teachers felt even less prepared for science instruction via online platform, and were not provided professional development, lessons, or activities at the district or building level.

The interview data from this study directly aligned with the research findings of Levy et al. (2008), which asserted that elementary teachers shared that, when feeling prepared to deliver science instruction, they struggle with feeling a sense of inadequacy, lack of content knowledge or pedagogical skill, or possessing only a surface-level understanding of how the science curriculum can be integrated with other subject areas. Levy et al. (2008) continued to say that increasing teachers' understanding of educational issues associated with science could prove to be the first and most critical step in raising awareness and building a building or district-level culture that appreciates the benefits that science education can have on education, the workforce, and the economy. Buildings that have chosen to implement a science teaching specialist maintain their priority focus on mathematics and ELA standards.

Conclusions

The current research study provided evidence of the underrepresentation of science instruction in the elementary classroom. Responsive interview data from elementary teachers of science and one science specialist provided the researcher with insight into the perceptions associated with the teaching and learning of science in each respondent's classroom. The existing literature indicated that various structural approaches to implementing a science teaching specialist could prove effective for preparing teachers and learners of science at the elementary level. Results of the analysis of the qualitative interviews may provide leaders with insight for future decision-making. Restructuring how elementary educators are prepared to deliver science instruction may shift the paradigm which may positively impact the structure and frequency of the science lessons, activities, and assessments which, hopefully, increase student achievement. If districts begin to prioritize science instruction, education leaders will implement it at the building level, and teachers will focus their efforts on addressing the science standards with the same passion they possess when meeting students' mathematics and literacy needs in the classroom.

Implications for action. The results from this study may have implications for schools that have identified underrepresentation of science education at the elementary level. The implications of this study also suggest that one effective approach to addressing the need for prioritizing science education is to implement a science specialist model to meet the needs of students. Several factors such as teacher preservice preparation, professional development and training, and collaborative communities should be considered when building leaders are deciding which approach will best meet the needs of staff and students. Seven structures for science specialists were identified in the literature review of this study, so educational leaders and decision-makers may identify the needs of their teachers and learners prior to determining which structure to implement. As the study included teacher perceptions regarding online teaching during a pandemic, there may be helpful information in the event schools are again forced to close. The absence of preparation time prior to this closure should provide clues to district leaders that pre-planning should be undertaken in the event there is another closure in the future. Based on this study's findings, those preparations should also include science instruction. Curriculum planners may want to confer with science instructors to determine what strategies work best in an online environment.

Recommendations for future research. The following recommendations represent areas for future investigations. Conduct:

1. A qualitative research study that extends the interviewing to other districts, to gather more experiences and opinions of the teaching and learning structures of elementary science.

2. A qualitative study to gather deeper insight into teacher preparation for elementary science only. The researcher could focus on preservice coursework, and follow professional development, training, and collaboration during their career as a classroom teacher or science teaching specialist.

3. A quantitative study comparing student assessment data at buildings that implement each of the seven structures for science specialists to determine which specialist structure is most effective at helping students meet proficiency.

4. A quantitative study that compares the student achievement scores on science assessments in buildings that departmentalize or utilize a science specialist compared with buildings that implement the traditional classroom teacher approach.

5. A mixed methods study to gather qualitative and quantitative data. Qualitative data gathered would be used to compare the perceptions, experiences, and opinions held by teachers at districts/buildings that departmentalize and utilize a science specialist with districts/buildings that implement the traditional approach. The quantitative data gathered would be used to compare the student assessment outcomes at the opposing buildings to determine which structure yields the greatest proficiency.

6. A mixed methods study to compare teacher perceptions and student data at buildings implementing each of the seven different structures for science specialists to determine which specialist approach has the most positive impact on student outcomes.

Concluding remarks. This study examined the perceptions of elementary teachers of science concerning their experiences and opinions of the teacher preparation, collaboration, and lesson delivery of science instruction. Participants' role in elementary science education, structure for lesson delivery, preparation for teaching, and impact of the COVID-19 pandemic were all considered in the interviewing process. The interviewer was able to interview six elementary teachers of science to gain insight into their perceptions of professional development, training, collaboration, and reflective feedback provided at the district, building, and classroom level. Overall, the interviewers agreed that science is underrepresented in the classroom due to the strict priority focus on mathematics and literacy standards to satisfy the verbiage in the district mission and vision that all students will read at proficiency by third grade and graduation rates will increase. It was the goal of the researcher to raise awareness to educational leaders, decision-makers, and advocates that elementary educators must begin to focus their efforts on science education as well as mathematics and literacy education to better prepare learners for growing and evolving science and technology rich 21st Century post-secondary education, careers, and job market.

References

Abell, S. K. (1990). A case for the elementary science specialist. *School Science and Mathematics, 90*(4), 291-301. Retrieved from ERIC database. (EJ410878)

Abell, S., Park, M., Rogers, Hanuscin, D., Lee, M., & Gagnon, M. (2008). Preparing the next generation of science teacher educators: A model for developing pck for teaching science teachers. *Journal of Science Teacher Education, 20*, 77–93. doi:10.1007/s10972-008-9115-6

Academic Partnerships. (2017). Importance of science education in schools. *University of Texas Arlington Online*. Retrieved from https://academicpartnerships.uta.edu/articles/education/importance-of-science-education.aspx

Albone, E. (1993). *Pupils as scientists*. Retrieved from http://www.clifton-scientific.org/about/pupils-as-scientists-1993.pdf

American Association for the Advancement of Science. (1993). [Website]. Retrieved from https://www.aaas.org/

American Association for the Advancement of Science. (1995). [Website]. Retrieved from https://www.aaas.org/

Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. New York, NY: Longman.

Ball, D., & Cohen, D. (1996). Reform by the book: What is—or might be—the role of curriculum materials in teacher learning and instructional reform? *Educational Researcher*, *25*(9), 6-8,14. https://doi.org/10.2307/1177151

Bell, R., Abd-El-Khalick, F., Lederman, N., McComas, W., & Matthews, M. (2001). The nature of science and science education. *Science & Education 10*(1), 187-204 doi:10.1023/A:1008712616090

Banilower, E., Smith, P.S., Weiss, I., Malzahn, K., Campbell, K., & Weis, A. (2013). *Report of the 2012 national survey of science and mathematics education.* 33-66. Retrieved from http://www.horizon-research.com/2012nssme/wp-content/uploads/2013/02/2012-NSSME-Full-Report1.pdf

Brownell, M., Yeager, E., Rennells, M., & Riley, T. (1997). Teachers working together: What teacher educators and researchers should know. *Teacher Education and Special Education. 20*(4), 340-59. Retrieved from ERIC database. (EJ581760)

Bruner, J. (1996). *Jerome Bruner, folk pedagogy, folk psychology*. Retrieved from http://oaks.nvg.org/bruner-folkology.html

Carlone, H. B., Scott, C., & Lowder, C. (2014). Becoming (less) scientific: A longitudinal study of students' identity work from elementary to middle school science. *Journal of Research in Science Teaching*, *51*(7), 836-869. https://doi.org/10.1002/tea.21150

Carter, Hodding, Jr. (2014). Where Main Street Meets the River. Rinehart Publishing.

Champagne, A. (2007). *Science education in the United States of America. Welcome to frontiers, 13*(7), 1-6. Retrieved from ERIC database. (EJ608194)

Chaney, B. (1995). Student outcomes and the preparation of eighth-grade teachers in science and mathematics: NSF/NELS:88 teacher transcript analysis. Rockville, MD: Westat. Retrieved from http://www.sciepub.com/reference/106654

Cook, J. (n.d.). Retrieved from https://classroom.synonym.com/importance-teaching-science-elementary-school-5810234.html

Cooke-Nieves, N. (2011). *A collaborative diagonal learning network: The role of formal and informal professional development in elementary science reform* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3484353)

Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative research designs: Selection and implementation. *The Counseling Psychologist*, *35*(2), 236–264. https://doi.org/10.1177/0011000006287390

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J. W. and Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Thousand Oaks, California: SAGE Publications.

Davison, D., & Miller, K. (2006). What makes a secondary school science and/or mathematics teacher "highly qualified?" *Science Educator*, *15*(1), 56-59. Retrieved from ERIC database. (EJ773254)

Dillon, J., Rickinson, M., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield, P. (2006). The value of outdoor learning: evidence from research in the UK and elsewhere. *School Science Review, 87*(320), 107-112. Retrieved from http://escuelainnatura.com/wp-content/uploads/2018/05/the_value_of_school_science_review_march_2006_87320_141.pdf

District X. 2020-2021 District Snapshot. Retrieved from https://www.[redacted]

Elliott, J. (2020). *Why use the 5e model for science instruction.* Retrieved from https://www.whatihavelearnedteaching.com/use-5e-model-science-instruction/

Forbes, C., & Davis, E. (2008). *Beginning elementary teachers' beliefs about the use of anchoring questions in science: A longitudinal study.* Retrieved from http://www.umich.edu/~hiceweb/PDFs/2008/NARST_2008_ForbesDavis_final.pdf

Friend, M., & Cook, L. (2013). *Interactions: Collaboration skills for school professionals* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Friend, M., & Cook, L. (2017). *Interactions: Collaboration skills for school professionals* (8th ed.). Upper Saddle River, NJ: Prentice Hall.

Fullan, M. G., & Hargreaves, A. (1991). *Working together for your school: Strategies for developing interactive professionalism in your school*. Melbourne, AU: Council for Educational Administration.

Garrett, Tracey. (2008). Student-centered and teacher-centered classroom management: A case study of three elementary teachers. *Journal of Classroom Interaction, 43(1),* 34 – 47. https://files.eric.ed.gov/fulltext/EJ829018.pdf

Gass, S., Mackey, A., & Ross-Feldman, L. (2005). Task-based interactions in classroom and laboratory settings. *A Journal of Research in Language Studies, 55*(4), 575-611. https://doi.org/10.1111/j.0023-8333.2005.00318.x

George, M. (2017). *Most primary classes "get less than two hours of science a week."* Retrieved from https://www.tes.com/news/most-primary-classes-get-less-two-hours-science-week

Gerretson, H., Bosnick, J., & Schofield, K. (2008). A case for content specialists as the elementary classroom teacher. *The Teacher Educator, 43*(4), 302-314. doi:10.1080/08878730802249866

Goddard, R. D., Hoy, W. K., & Woolfolk-Hoy, A. (2000). Collective teacher efficacy: Its meaning, measure, and impact on student achievement. *American Educational Research Journal, 37*, 479-507. https://doi.org/10.3102/00028312037002479

Goddard, Y., Miller, R., Larson, R., Goddard, R., Madsen, J., Schroeder, P. (2007). *Connecting principal leadership, teacher collaboration, and student achievement*. Retrieved from ERIC database. (ED528704)

Goldhaber, D. D., and Brewer, D. J. (1997). Why Don't Schools and Teachers Seem to Matter? Assessing the Impact of Unobservables on Educational Productivity. *Journal of Human Resources*, 32/3, 505-523. Retrieved from https://econpapers.repec.org/article/uwpjhriss/v_3a32_3ay_3a1997_3ai_3a3_3ap_3a505-523.htm

Goldhaber, D.D., and Brewer, D. J. (2000). Does Teacher Certification Matter? High School Teacher Certification Status and Student Achievement. 22/2. 129-145. Retrieved from https://journals.sagepub.com/doi/10.3102/01623737022002129

Grade Power Learning. (2018). *What is inquiry-based learning (and how is it effective)?* Retrieved from https://gradepowerlearning.com/what-is-inquiry-based-learning

Greenwood, A., & Scribner-MacLean, M. (1997). *Examining elementary teachers' explanations of their science content knowledge.* Retrieved from ERIC database. (ED406161)

Gutek, G. L. (2018). *History of education.* Retrieved from https://education.stateuniversity.com/pages/1950/Elementary-Education.html

Hawkins, J. D., Abbott, R., O'Donnell, J., Hill, K., Kosterman, R., Catalano, R. (1998). Changing teaching practices to promote achievement and bonding to school. *American Journal of Orthopsychiatry, 68*(4), 542-552. https://doi.org/10.1037/h0080363

Herbert, S., Xu, L., & Kelly, L. (2017). The changing roles of science specialists during a capacity building program for primary school science. *Australian Journal of Teacher Education, 42*(3), 1-21. http://dx.doi.org/10.14221/ajte.2017v42n3.1

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics.* Retrieved from ERIC database. (ED509653)

Hindin, A. (2007). More than just a group: Teacher collaboration and learning in the workplace. *Teachers and Teaching*, *13*(4), 349-376. doi:10.1080/13540600701391911

Horizon Research Foundation. (2007-2021). *Science at the horizon of life*. Retrieved from http://www.horizonresearch.org/

Hounshell, P. (1987). Elementary science specialists? Definitely! *Science and Children*, *24*(4), 20, 157. Retrieved from ERIC database. (EJ354636)

Jones, M. G., & Edmonds, J. (2006). Models of elementary science instruction: Roles of science specialist teachers. In K. Appleton (Ed.), *Elementary science teacher* *education: International perspectives on contemporary issues and practice*. 317-344. Retrieved from https://eric.ed.gov/?id=ED493760

Klein, A. (2015, April). No Child Left Behind: An overview. *Education Weekly*. Retrieved from https://www.edweek.org/policy-politics/no-child-left-behind-an-overview/2015/04

Leader in Me. (2021). *Elementary schools.* Retrieved from https://www.leaderinme.org/elementary-school/.

Levy, A. J., Pasquale, M. M., & Marco, L. (2008). Models of providing science instruction in the elementary grades: A research agenda to inform decision makers. *Science Educator 17*(2), 1-18. Retrieved from ERIC database. (EJ851871)

Little, J. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record*, *91*(4), 509-536. Retrieved from ERIC database. (EJ412496)

Longman's Dictionary. (2021). Pedagogy. Retrieved from https://www.ldoceonline.com

Lortie, D. C. (1975). *Schoolteacher: A sociological study.* Chicago: University of Chicago Press.

Lunenburg, F. C., & Irby, B. J. (2008). *Writing a successful thesis or dissertation: Tips and strategies for students in the social and behavioral sciences.* Thousand Oaks, CA: Corwin Press.

Mangrubang, F. (2004). Preparing elementary education majors to teach science using an inquiry-based approach: The full option science system. *American Annals of the Deaf, 149*(3), 290-303. doi:10.1353/aad.2004.0028

Marco-Bujosa, L., & Levy, A. (2016). Caught in the balance: An organizational analysis of science teaching in schools with elementary science specialists. *Science Education, 100*(6), 983-1008. https://doi.org/10.1002/sce.21239

Marx, R., & Harris, C. (2006). No Child Left Behind and science education: Opportunities, challenges, and risks. *Elementary School Journal, 106*(5), 455-466. Retrieved from https://www.journals.uchicago.edu/doi/abs/10.1086/505441

Mensah, F. (2012). Positional identity as a lens for connecting elementary preservice teachers to teaching in urban classrooms. *Identity Construction and Science Education Research, 35*, 103–121.

Mongeau, L. (2018). *Will new standards improve elementary science education? Science has rarely been considered a priority in elementary school, but that may be changing*. Retrieved from https://hechingerreport.org/will-new-standards-improve-elementary-science-education/

Monk, D. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of Education Review, 13*(2), 125-45. Retrieved from ERIC database. (EJ487878)

Mulvahill, E. (2016). *Should elementary schools departmentalize? We look at the pros and cons.* Retrieved from https://www.weareteachers.com/should-elementary-schools-deparmentalize-we-look-at-the-pros-and-cons

National Academies of Science. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.* Retrieved from http://media.ride.ri.gov/eeie/Resources/KeyNGSSDocs/Framework_for_K12_Science_Education.pdf

National Academies Press. (2007). *Taking science to school: Learning and teaching science in grades k-8.* Retrieved from http://www.nap.edu

National Research Council. (2000). *How people learn: Brain, mind, experiences, and school.* Retrieved from https://coggle.it/diagram/XiZQv2Yss8jzH3x_/t/national-research-council-2000-how-experience%2C-and-school

National Science Teachers Association. (2021). *Access the next generation science standards by topic.* Retrieved from https://my.nsta.org/ngss/AccessStandardsByTopic

Nelson, G., & Landel, C. (2007). A collaborative approach for elementary science. *Educational Leadership, 64*(4), 72-75. Retrieved from ERIC database. (EJ766310)

Nelson, T. (2020). The Holy Bible: *New King James Version.* Nashville, TN

Next Generation Science Standards. (2013). Conceptual Shifts in the Next Generation Science Standards. Appendix A. Retrieved from https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20A%20%204.11.13%20Conceptual%20Shifts%20in%20the%20Next%20Generation%20Science%20Standards.pdf

No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002). Retrieved from https://www.congress.gov/bill/107th-congress/house-bill/1

New South Wales Department of Education. (2021). *Specialists teachers.* Retrieved from https://teach.nsw.edu.au/exploreteaching/types-of-teachers/specialist-teachers

Osborne, J. (2014). Teaching critical thinking? New directions in science education. *Perspectives on the Science Curriculum, 95*(352), 53-60. Retrieved from http://www.physics.smu.edu/sdalley/quarknet/2015/2015QuarkNet_files/Physics%20Curriculum%20Constructs/ASE%20Teaching%20Critical%20Thinking%20in%20Science%20Education.pdf

PhDStudent. (2021). *Stating the Obvious: Writing Assumptions, Limitations, and Delimitations*. Retrieved from: https://www.phdstudent.com/thesis-and-dissertation-survival/research-design/stating-the-obvious-writing-assumptions-limitations-and-delimitations.

Reid, K. (2012). A study regarding content specialist team-teaching at the elementary level in a southwest Washington school. *Wisdom Of Practice: An Online Journal of Action Research.* Retrieved from https://labs.wsu.edu/journal-of-action-research/documents/2016/05/a-study-regarding-content-specialist-team-teaching-at-the-elementary-level-in-a-southwest-washington-school.pdf/

Rhoton, J., Field, M. H., & Prather, J. P. (1992). An alternative to the elementary school science specialist. *Journal of Elementary Science Education 4*(14). Retrieved from https://doi.org/10.1007/BF03173751

Ronan, D. (2014). *Science specialists in urban elementary schools: An ethnography examining science teaching identity, motivation and hierarchy in a high stakes testing climate* (Doctoral dissertation). Retrieved from the ProQuest Dissertations & Theses Global: The Humanities and Social Sciences Collection. (ProQuest No. 3622719)

Rowan, B., Correnti, R., & Miller, R. J. (2002). *What large-scale, survey research tells us about teacher effects on student achievement: Insights from the prospects study of elementary schools*. Consortium for Policy Research in Education, Research

Report. Retrieved from http://www.americancivil.literacy.org/sites/default/files/researchreport/791_rr51.pdf

Rubin, H. J., & Rubin, I. S. (2012) *Qualitative interviewing: The art of hearing data* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Sanders, L., Borko, H., & Lockard, J. (1993). Secondary science teachers' knowledge base when teaching science courses in and out of their area of certification. *Journal of Research in Science Teaching, 30*(7), 723-736. https://doi.org/10.1002/tea.3660300710

Schwartz, R., Adb-El-Khalick, F., & Lederman, N. (2000). An exploratory study of the "effectiveness" of elementary science specialists. *School Science and Mathematics, 100*(4), 181-192. Retrieved from https://www.researchgate.net/publication/234633700_An_Exploratory_Study_of_the_Effectiveness_of_Elementary_Science_Specialists

Schwartz, R., & Gess-Newsome, J. (2008). *Elementary science specialists: A pilot study of current models and a call for participation in the research.* Retrieved from ERIC database. (EJ851873)

Seymour, E. & Hewitt, N.M. (1994). *Supporting science instruction*. Retrieved from https://www.nap.edu/read/11625/chapter/12

Smith, L. D., Best, L. A., Stubbs, D. A., Johnston, J., & Archibald, A. B. (2000). Scientific graphs and the hierarchy of the sciences: A Latourian survey of inscription practices. *Social Studies of Science, 30*(1), 73–94. https://doi.org/10.1177/030631200030001003

Statistics Solutions. (2021). *Complete dissertation by statistics solutions: Expert guidance every step of the way*. Retrieved from https://www.statisticssolutions.com/what-is-trustworthiness-in-qualitative-research/

Straus, L. (2007). From experience to law: Leo Strauss and the Weimar crisis of the philosophy of religion. *History of European Ideas, 33*(2), 174-194. Retrieved from https://www.tandfonline.com/doi/abs/10.1016/j.histeuroideas.2006.11.004

Thompson, M. (n.d.). *What is a generalist teacher?* Retrieved from https://woman.thenest.com/generalist-teacher-20920.html

Tilgner, P. (1990). Avoiding science in elementary school. *Science Education*, *74*(4), 421-431. https://doi.org/10.1002/sce.3730740403

Trumbull, D., & Kerr, P. (1993). University researchers' inchoate critiques of science teaching: Implications for the content of preservice science teacher education. *Science Education*, *77*(3), 301-17. Retrieved from ERIC database. (EJ482235)

Trygstad, P., Smith, P., Banilower, E., & Nelson, M. (2013). *The status of elementary science education: Are we ready for the next generation science standards?* Retrieved from ERIC database. (ED548249)

Tschannen-Moran, M., Woolfolk, Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*(7), 783-805. Retrieved from ERIC database. (EJ640149)

United States Department of Education. (2019). *Every Student Succeeds Act*. Retrieved from https://www.ed.gov/essa?src=rn

University of Texas at Arlington Online. (2021). [Website]. Retrieved from https://academicpartnerships.uta.edu/

Windschitl, M. (2004). Folk theories of inquiry: How preservice teachers reproduce the discourse and practices of a theoretical scientific method. *Journal of Research in Science Teaching, 41*(5), 481-512. Retrieved from https://onlinelibrary.wiley.com/doi/10.1002/tea.20010

Wisconsin Department of Public Instruction. (n.d.). *Why elementary science?* Retrieved from https://dpi.wi.gov/science/elementary/why

Yager, R. (2020). *Science education.* Retrieved from https://www.encyclopedia.com/science-and-technology/technology/technology-terms-and-concepts/

Yearwood, C. (2011). *Effects of departmentalized versus traditional settings on fifth graders' math and reading achievement*. Retrieved from https://www.atlantapublicschools.us/

Zahradnik, B. (2018). S*cience instruction that engages & prepares students for future success.* Retrieved from https://www.leaderinme.org/blog/science-instruction-that-engages-and-prepares-students-for-future-succes/

Appendices

Appendix A. District Approval for the Study

[redacted]

January 22, 2020

To: Myesha Robertson
[redacted]

Re: Dissertation Proposal

Dear Myehsa Robertson,

This letter is in response to your recent request regarding your research titled: *Departmentalized Classroom Environments Versus Traditional Classroom Environments for Elementary Science Instruction: A Mixed Methods Analysis* in the [redacted] Schools. The Research Council has approved your request as presented in the proposal. However, the Council recommends clarification in the dissertation that the two schools have significant demographic differences. Unfortunately, none of the other elementary schools that departmentalize science are a good comparison with [redacted] Elementary.

As you proceed with your study, please note that this letter approves the research project as described above, and that it is incumbent upon the researcher(s) to negotiate distribution. The project also must not unduly increase the workload of any employee of the [redacted] Schools. The [redacted] Schools staff has the right to discontinue participation at any time. If for any reason it becomes necessary to modify what was originally presented in your proposal, the Research Council must be so informed and approve any changes in advance.

Please submit copies of any reports related to this research to the Office of Assessment and Research and if applicable, be made available to the participating school(s) as well.

On behalf of the [redacted] Research Council,

[redacted]

[redacted] Executive Director
Assessment and Research
[redacted] Schools

Appendix B. Institutional Review Board Approval for the Study

Baker University Institutional Review Board

May 12th, 2021

Dear Myesha Robertson and Harold Frye,

The Baker University IRB has reviewed your project application and approved this project under Expedited Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.
6. If this project is not completed within a year, you must renew IRB approval.

If you have any questions, please contact me at npoell@bakeru.edu or 785.594.4582.

Sincerely,

Nathan D. Poell

Appendix C. Consent to Participate

Consent to Participate

Research Title: Departmentalized Classroom Environments Versus Traditional Classroom Environments for Elementary Science Instruction: A Qualitative Analysis

Researcher: Myesha D. Robertson

Advisor: Dr. Harold Frye

School of Education

Baker University

7301 College Blvd.

Overland Park, KS 66210

(913)-344-1220

harold.frye@bakeru.edu

My name is Myesha Robertson, a doctoral student at Baker University in Kansas and educator in [redacted] Public Schools. I am conducting research on teachers' perceptions of elementary science teaching and learning. I am also interested in teachers' perceptions of departmentalizing for core subjects, and what effects, if any, that the COVID-19 pandemic has had on their teaching practices.

As an interview participant, you will be asked to answer approximately 24 open ended questions relating to your perceptions, experience, and opinions concerning the structure, teacher preparation, and engagement strategies for elementary science instruction. Your participation is voluntary; therefore, you may decline to answer any question at any time. Furthermore, you may terminate your participation at any time for any reason you deem necessary.

Any personal and confidential information that would be considered identifiable, such as name, building site, and position will all be kept confidential and access will be restricted. Interview transcripts will be password protected. The researcher, university research advisor and analyst will be the only individuals with permissions to access study data and documentation.

Statement of consent to participate:

I understand that my participation in this research study is entirely voluntary. Moreover, I understand that I have the right to terminate my participation and recant any statements that I provided during this study at any time for any reason. I understand that the principal investigator can be contacted at mrobertson2@[redacted] should any questions or concerns arise or if I wish to terminate my statements and/or participation.

I have read and understand the above statement. By signing, I agree to participate in the research study. The Baker University Institutional Review Board approved this study on _____________ and will expire on ______________ unless renewal is obtained by the review board.

Participant Signature_______________________________________Date________________