Middle School Administrators' Perceptions of Their Engagement in Leadership Practices for Next Generation Science Standards Instruction

Janel N. Paschall
B.A., Fisk University, 2001
M.S., Pittsburg State University, 2004
M.A., University of Missouri- Kansas City, 2009

Submitted to the Graduate Department and Faculty of the School of Education of Baker University in partial fulfillment of the requirements for the degree of Doctor of Education in Educational Leadership

Susan K. Rogers, Ph.D.
Major Advisor

Denis Yoder, Ed.D.

Stacey King, Ed.D.

Date Defended: October 25, 2022

Abstract

In June 2013, Kansas adopted the Next Generation Science Standards (NGSS) for science education. Some of the content of the new curriculum introduces advanced subject matter much earlier in K-12 science education, and this change requires higher levels of support for instruction and achievement (Pruitt, 2014). Building principals are the first source of professional support for teachers seeking guidance and leadership in the classroom (Prince, 2022). The purpose of this study was to determine the perceived engagement of middle school administrators in instructional leadership practices for supervising NGSS-related instruction. The researcher worked to determine the extent middle school administrators report engagement in leadership practices for science instruction, such as setting goals, supervising, coordinating resources, evaluating, establishing staff development, establishing school climate, and developing school and community relations. An additional purpose of this study was to determine the extent gender, number of years of teaching experience, and number of years worked in administrative positions of middle school administrators influences reported engagement in leadership practices for science instruction. Participants completed the original version of a five-point Likert- type scale survey, "Instructional Activity Measurement Subscale," developed by Heck (1985), to address four research questions and 44 hypotheses at the focus of the research. The survey was administered during the COVID- 19 pandemic and resulted in a small number of participant responses. Despite the small number of survey responses, the results of the hypothesis testing indicated that middle school administrators perceive that they frequently or always perceived they engaged in seven of the 11 leadership practices for science instruction. Gender and years of teaching experience were not a basis for significant differences in reported engagement in leadership behaviors. Building and district administrators are highly encouraged to participate in science-specific professional development training to advance instructional leadership skills related to the supervision of NGSS instruction. Engagement in this learning by leaders presents opportunities to identify and compare instructional leadership behaviors across various subjects, an understanding of subject-specific behaviors, and learn additional leadership behaviors to provide greater support. Research on content-specific instructional leadership behaviors by principals supervising curriculum instruction and learning, instructional and professional development of science teachers, and standardized test performance of students learning NGSS and non- NGSS science curricula is suggested for future study.

Dedication

To my nephew Ellis, you are the purest love I have ever known and the greatest blessing to my life. Although this world is a big, scary place full of experiences, I hope I will inspire you to dream beyond belief. Do not let anything stop you from finding and fulfilling your purpose. Believe that nobody gets to determine what happens to you except you and God, so get up every day and just keep going. Remember who you are!

Acknowledgments

In the biblical world, it is said that the number seven represents completion. It has taken me seven years to complete this work. Not one part of it was achieved without some of the most incredible education professionals that I have ever met towing me along the way. Whenever hardship, obstacles, and breakdown occurred in my life, my Baker cohort of colleagues, instructors, and administration stepped in to support me.
There are not enough words or gestures in the world to convey my gratitude and appreciation, but still, I will try.

Dr. Susan Rogers, you mean the world to me! While I do not scare easily, your stern demeanor and unbeaten reputation frightened me from the first day we met (taking my admission exam). I thought I had met my end when you were assigned to be my advisor, but as it turned out, I was wrong, and I have never been happier. My fear has been replaced with the utmost adornment and love due to your guidance and encouragement. There is no way that I have completed this degree without you. With my whole heart, I thank you.

Dr. Waterman and Dr. Yoder, it is a privilege to have you participate in my studies and defense committee. Your expertise in your respective areas of academia is admirable, and I hope to become as great as you. Dr. Kokoruda, Dr. Robbins, and Dr. Frye, each of you, has been pivotal in this journey of mine. Thanks to you, I am a better student, educator, and professional. The impact each of you has made on me will be reflected in every aspect of my future.

Dr. Stacy Heard King, thank you for your investment in me. The personal conversations of counsel, inspiration, and advice have been invaluable. Your professional work during my field experience uncovered ideas, goals, and opportunities awaiting my pursuit. You have given me a new perspective and direction for the future of my career. You are not only a colleague, but you have also become a friend. I am forever thankful.

Chad Heckert- when life tried to force me to stop, God gave me saving grace through you. I will never stop thanking you for standing up for me when I could not. God bless you.

Table of Contents

List of Tables

Chapter 1

Introduction

Science education in K-12 schools in the United States is the most understudied topic in education (Kuenzi, 2008). Since 1997, there has been a steady decline in awarding science degrees and pursuing science, technology, engineering, and mathematics (STEM) careers in the United States. Researchers at the National Science Foundation believe that too few American students and graduates are pursuing careers in STEM fields because the previous science education standards were not engaging or innovative enough, hence the development of Next Generation Science Standards (NGSS) (Kuenzi, 2008). Kuenzi (2008) stated, “Although the number of degrees in some STEM fields (particularly biology and computer science) has increased in recent decades, the overall proportion of STEM degrees awarded in the United States has historically remained at about 17% of all postsecondary degrees awarded” (p. 1).

Before the NGSS reform, science education in the United States consisted of memorizing facts, theories, and concepts about the earth, space, and natural phenomena presented by teachers and led by the content textbooks (Lowenhaupt & McNeill, 2019). Teachers cannot be held solely responsible for teaching and learning within this reform because one of the many tasks of principals is the supervision of curriculum and student performance. NGSS was created to shift science learning from teacher-driven fact sharing to student-centered science practice: question, exploration, discussion, and critique. Such a shift in instruction has required support for teachers from leadership on how to enhance the teaching and learning of both teachers and students to meet the goals of NGSS (Lowenhaupt & McNeill, 2019). School leaders and district administrators are well- informed in instructional behaviors and practices universal to all subjects; however, leaders and administrators typically lack subject-specific background knowledge or expertise to support teachers' curriculum needs and requirements in their schools and classrooms, especially at the secondary education level (Quebec Fuentes & Jimerson, 2020). The application and utility of general leadership behaviors and instructional practices have been shown to influence student achievement and school success overall, but an examination of how those general behaviors and practices affect achievement and success per subject has yet to be fully explored (Andrews & Soder, 1987; Hallinger, 2005; Quinn, 2002; Stein & Nelson, 2003). Therefore, research is needed to examine how principals fulfill the requirements to be effective instructional leaders in a science-specific context (Winn, 2016).

Since 2013, the science curriculum taught in some United States schools has changed with the adoption and implementation of the NGSS in 20 states (NGSS, 2021b). These standards have mapped out international theories, concepts, and principles of science and technology instruction to be performed by teachers and mastery of exploratory learning by students universally to improve science education, as well as promote advanced education and career interests in STEM (NGSS, 2016). The NGSS are different from previous science standards because they challenge instructors to elevate classroom instruction of the subject and students to engage in deeper cognitive thinking, learning, and practices demonstrated through scientific assessment measures (NGSS, 2013). Implementing NGSS in K-12 education requires elaborate professional development experiences to provide significant instructional support for science teachers from school administrators, specifically building principals and assistant principals (NGSS, 2017). Spillane, Diamond, Waler, Halverson, and Jita (2001) found that principals with science instruction proficiency are valuable and essential, especially when leading during changes in a science curriculum.

Background

NGSS represents a body of performance expectations required of students to demonstrate a deeper understanding of disciplinary core ideas, showing evidence of knowledge through scientific and engineering practices while making cross-cutting connections between curriculums. According to Pruitt (2014), the National Research Council led the first phase of a two-step process that involved several organizations. The second phase was led by 26 states and facilitated by Achieve to develop *A Framework for K-12 Science Education*. The researcher asserts, “The goal of the Framework was to articulate the vision for science education in the 21st century and what students need to know in their K-12 experience to be considered scientifically literate” (Pruitt, 2014, p. 146). Past science education often focused on memorizing facts to explain natural and scientific phenomena while conducting inquiry separately; however, one critical role of NGSS is redefining rigor within state science curriculum standards. Science practices are not simply pedagogical strategies but a demonstration of knowledge with the skill to investigate each practice, “connecting the knowledge of how scientists work with how the science works” (Pruitt, 2014, p. 150). This curriculum reform purposefully incorporates the application of scientific knowledge into inquiry practice for students to demonstrate mastery and understanding.

In 2004, $3 billion of federal funding was invested in U.S. STEM programs across the country by the National Institutes of Health and the National Science Foundation (Kuenzi, 2008). In 2007, the control over STEM programming was transferred from the National Institutes of Health and the National Science Foundation to the Government Accountability Office, which offered this program as one component of the American Competitiveness Initiative passed into law by Congress (Kuenzi, 2008). "Achieve coordinated the work of twenty-six Lead State Partners and collaborated with critical partners, including the National Research Council, the National Science Teachers Association, and the American Association for the Advancement of Science, to develop the NGSS based on the *NRC's K-12 Framework for Science Education" (NGSS Developing the Standards, 2021)*. According to the National Research Council (2012), the development of the NGSS required education experts and scientists with advanced skills and higher-level knowledge about science thinking and inquiry to create the template. High-quality, robust science education means students develop an in-depth understanding of content and gain knowledge and skills (i.e., communication, collaboration, inquiry, problem-solving, and flexibility) that will serve their educational and professional lives (NGSS, 2016).

The NGSS were benchmarked against countries whose students perform well in science and engineering, including Finland, South Korea, China, Canada, England, Hungary, Ireland, Japan, and Singapore (NGSS, 2016). The average *Trends in International Mathematics and Science Study* (TIMSS) science scores of U.S. eighth-grade students were among the top 20 countries in student performance over the past 20 years (Institute of Education Sciences & National Center for Educational Statistics, 2015). The average TIMSS science scores of eighth-grade students by country or jurisdiction in 2003 was 527, ranking the U.S. 10th among other countries (the international average was 473). In 2011, the U. S. scored an average of 525, again ranking 10th among other countries (the international average was 473) (Institute of Education Sciences & National Center for Educational Statistics, 2011). The decline in the average score continued for the U.S. in 2019, scoring 522, falling in rank to 11th among other countries (the international average was 500) (Institute of Education Sciences & National Center for Educational Statistics, 2019) (see Table 1).

Table 1

TIMSS Science Score Average of Grade 8 Students in the United States

Assessment Year	Unites States Score	International Average	International Rank
2003	527	473	10th
2011	525	473	10th
2019	522	500	11th

Note. Adapted from *TIMSS 2019 U. S. Highlights Web Report (NCES 2021-021)*, by the Institute of Education Sciences & National Center for Educational Statistics, 2003, 2011, 2019. Retrieved from https://nces.ed.gov/timss/results19/index.asp

Kansas served as a lead state partner during the development of the NGSS content in 2011 (NGSS, 2021a). As one of the 26 state lead partners, the Kansas State Department of Education (KSDE) and school superintendents agreed that Kansas would serve as a pilot state for the development, adoption, and implementation process for the NGSS curriculum guide (Pruitt, 2014). State science leaders attended writers' meetings to offer direction and provide input on content in life, physical, earth, and space science to create student performance expectations for the new science guide. Until 2007, the Kansas requirement for high school science education mandated three years of science courses (biology, physical science, earth/space science) with one laboratory course included. State assessments were conducted in Grades 4, 7, and one time during high school by Grade 11. Using the Framework for K-12 Science Education, NGSS science concepts have three main dimensions: disciplinary core ideas, scientific and engineering practices, and crosscutting concepts (NGSS, 2013) and serve as the guiding force of science education standards across the state. KSDE formally adopted and implemented the NGSS curriculum standards in June 2013 (NGSS Lead States, 2021).

The four main disciplines of science are life, physical, earth, and space science. These disciplines involve the strategic incorporation of engineering and technology concepts and practices while connecting advanced elements of scientific inquiry, critical-thinking exploration, and cross-cutting curriculum to other subjects (Bybee, 2014). The NGSS allowed educators to teach effectively, moving their approach toward the way students learn best—in a hands-on, collaborative, and integrated environment rooted in inquiry and discovery, and calling for more student-centered learning that enables students to think on their own, problem-solve, communicate, and collaborate—in addition to learning critical scientific concepts (NGSS, 2016). The NGSS divides science education into seven standards that are clustered into groups of benchmarks mastered through the K-12 education experience. Within the standards are indicators taught as blended ideas of what students should know, understand, and be able to perform at grade levels K- 2, 3-4, 5-7, and 8-12 in the areas of science:

a. Science as Inquiry
b. Physical Science (Physics and Chemistry)
c. Life Science
d. Earth and Space Science
e. Science and Technology
f. Science in Personal and Environmental Perspectives
g. History and Nature of Science (KSDE, 2007, p. viii)

Pruitt (2014) explained that great care must be taken with NGSS instruction to ensure the learning progression of disciplinary core ideas to allow students to make sense of the world. Teaching the performance expectations one at a time could lead to a disjointed view of science, whereas teaching a standard unit should be like telling a "story" across the whole grade or course (Pruitt, 2014). Another critical role of NGSS is the engineering design of science – the point where understanding science content is used to solve a problem or improve a situation. The engineering design is most important to students' success in the 21st century because these standards challenge students to define problems and design solutions within traditional sciences (Pruitt, 2014).

Pruitt (2014) also recognized that challenges with the adoption and implementation of NGSS have included the quality of the science standards compared to existing science standards, the influence of political climate on government educational leadership, and the type of feedback from political constituents about reform based on the political environment. Several states adopted the NGSS guide within six months of the release of its final draft (Bybee, 2014). By 2021, only 20 states had adopted the curriculum, while others had elected to develop their reformed science standards based on government influences (Pruitt, 2014). States have been warned against rushed implementation of the curriculum guide to prepare state education systems for the incorporation and assessment periods. Pruitt (2014) further explained the suggested timeline for completing implementation in several years to develop and use professional development training, create new policies, and realign fiscal and educational resources. Added challenges exist in developing quality materials and building professional awareness in the education field. Pruitt (2014) stated that difficulty arises in helping educators deeply understand what NGSS and the K-12 "framework are, understanding the vision, internal coherence, and deliberate use of science terminology with the new science standards, and understanding the knowledge associated with science practices and the application of them beyond pedagogy" (p. 153). Furthermore, developing adequate assessments representative of 21st-century science education presents the most significant challenge.

Statement of the Problem

A gap exists in the research examining content-specific leadership (Burch & Spillane, 2003; Lochmiller, Huggins, & Acker-Hocevar, 2012). Literature on instructional leadership is common; however, more specific topics such as differences in instructional leadership behaviors per content curriculum or grade level, or leadership practices utilized by instructional leaders based on professional background/ experience is scarce, if not almost nonexistent, especially in science (Lowenhaupt & McNeill, 2019; Williams, 2019). In the past, researchers looking into the topic of instructional leadership have examined the topic, generally regarding mathematics and reading instruction (Robinson, Lloyd, & Rowe, 2008) and studied leadership in single districts (Hallinger, Wang, Chen, & Li, 2015), or the research has not been specific to leadership for the NGSS curriculum. Previous research studies have shown that various content areas call for leadership tailored to academic subjects (Burch & Spillane, 2003; Lochmiller, 2016; Lochmiller et al., 2012; Winn, 2016). Burch and Spillane (2003) stated that field-specific approaches to inquiry, purposes and unique epistemological orientations are to be honored differently by educators in each subject. Similarly, Lochmiller et al. (2012) explained

> Beyond pedagogy, teachers and building administrators must be capable of analyzing the relationship with specific content by asking questions, such as:

> What is adequate content knowledge? How do I assess it? How can a teacher's content knowledge be improved when it is deficient? (p. 203)

Stein and Nelson (2003) examined how the role of school principals has moved from administrative to curriculum and instruction, adding to the demands of science reform that require substantial instructional leaders who understand the various subject areas under their supervision. Principals can positively influence student learning based on their engagement in instructional leadership (Lochmiller et al., 2012). Building administrators serving as instructional leaders focus their work on expectations for teaching and learning, such as mapping curriculum, developing clear, measurable learning objectives, and continuous focus on student performance, improvement, and achievement by supporting the work of teachers (Lochmiller et al., 2012). The reform of U.S. science education with NGSS in public schools aims to abolish the mere task of learning science facts and engage students in constructive and critical thinking, like scientists (Lowenhaupt & McNeill, 2018; Pruitt, 2014).

Building principals are the first source of instructional support for teachers navigating these science benchmarks (Bybee, 2014; Pratt, 2013; Winn, 2016). Most building administrators do not have formal degrees in science and have limited experience teaching science (Winn, 2016). Further research is needed to examine middle school administrators' leadership practices for science instruction.

Purpose of the Study

The first purpose of this study was to determine the extent middle school administrators report engagement in leadership practices for science instruction, such as setting goals, supervising, coordinating resources, evaluating, establishing staff development, establishing school climate, and developing school/ community relations. The second purpose of this study was to determine the extent the gender of middle school administrators influences reported engagement in leadership practices for science instruction. The third purpose of this study was to determine the extent the number of years of teaching experience of middle school administrators influences reported engagement in leadership practices for science instruction. The fourth purpose of this study was to determine the extent the number of years worked in administrative positions influences middle school administrators' reported engagement in leadership practices for science instruction.

Significance of the Study

There can be several benefits from this study:

- the middle school administrators' reported engagement in leadership practices for science instruction might be identified.
- target areas for increased support in NGSS instruction could guide goal setting, improvement planning, and school achievement.
- extend professional knowledge on assessing administrator engagement in science curriculum reform and implementation.
- offer ideas for redeveloping leadership training and professional development curriculum for administrators and curriculum leaders responsible for science

education in their schools and districts to build and enhance subject matter expertise.

With the shortage of literature on principals' leadership in science, this study contributes to the literature exploring the practices of United States' middle school principals in science. Moreover, this study's results can add new information to the literature pool of research on NGSS and instructional support.

Delimitations

"Delimitations are self-imposed boundaries set by the researcher on the purpose and scope of the study" (Lunenburg & Irby, 2008, p. 134). The delimitations for this study included the following:

1. The participants were employed as middle school administrators in Kansas school districts. Participants did not include science department chairs or directors serving at the district-office level.
2. The data was collected during the spring semester of the 2021-2022 school year.
3. The participants were contacted via email and provided a link to an online survey.

Assumptions

According to Lunenburg and Irby (2008), assumptions are made about the "nature, analysis, and interpretation of the data" (p. 135). Assumptions made for this study were primarily focused on the participants. Assumptions made in this study are as follows:

1. The participants held responsibility for supporting science instruction in a Kansas public school district.

2. The participants understood the survey items and the purpose of the study.
3. The participants were honest while responding to the items posed in the survey.

Research Questions

The researcher aimed to explore the perceptions of middle school administrators' capacity to support science instruction and learning of the NGSS based on their educational and professional backgrounds. To examine this topic, the following four research questions were posed:

RQ1. To what extent do middle school administrators perceive they are engaged in leadership practices for science instruction?

RQ2. To what extent does gender influence middle school administrators' perceived engagement in leadership practices for science instruction?

RQ3. To what extent does the number of years of teaching experience influence middle school administrators' perceived engagement in leadership practices for science instruction?

RQ4. To what extent does the number of years worked in administrative positions influence middle school administrators' perceived engagement in leadership practices for science instruction?

Definition of Terms

The demands of science reform require skilled instructional leaders to support a shifting vision of science teaching and learning at the K- 8 level. Definitions in this section provide an understanding of how the key terms are used within the context of this study.

Instructional leadership. Leithwood (1994) defined instructional leadership as a series of behaviors specifically used to affect classroom instruction.

Leadership content knowledge. Quebec Fuentes and Jimerson (2020) explained that leadership content knowledge is a specific area of expertise from administrative professionals based on academic, teaching, and career backgrounds.

Middle school. According to the Merriam-Webster Dictionary Online (2022), a middle school is an educational institution where students in Grades 5-8 or 6-8 are taught.

Organization of Study

This study is organized into five chapters. Chapter 1 was the introduction to the study and included the background, the statement of the problem, the purpose of the study, delimitations, the assumptions, the research questions, and the definition of terms. Presented in Chapter 2 is the relevant literature, including content knowledge leadership, instructional leadership practices, and administrator engagement in leadership practices. Chapter 3 includes an explanation of the study's methodology, including the research design, selection of participants, measurement, data collection procedures, data analysis, and hypothesis testing, and limitations of the study. In Chapter 4, the descriptive statistics and the results of the hypothesis testing are provided. Chapter 5 presents the study summary, findings related to the literature, and conclusions.

Chapter 2

Review of the Literature

Many questions can arise when studying instructional leadership. Some topics within the subject have been found to be of greater interest than others: standard characteristics and practices of instructional leadership, leadership performance methods across state assessment grade levels and curriculum areas, types of research performed, and instructional leadership theories. The topics addressed in this chapter are instructional leadership practices and content knowledge leadership, and engagement in leadership practices in science.

Instructional Leadership Practices

Larsen (1985) conducted a study to determine the most crucial instructional leadership behaviors and the degree to which principals implemented the behaviors in high- and low-achieving schools based on standardized test scores in mathematics and reading. Leadership behaviors examined several influential factors on student academic achievement. Based on a literature review, 44 leadership behaviors were identified and ranked by national education experts to narrow the list to the 29 “most important” instructional leadership behaviors to include in the Instructional Activity Questionnaire (Larsen, 1985, p. 76).

Larsen (1985) asked teachers and principals to rate the degree to which the principal implemented each instructional behavior at their school site to compare high-achieving and low-achieving schools. Teachers in high-achieving schools rated their principals as displaying instructional leadership behaviors more frequently than teachers of low-achieving schools for 10 of the 29 specified behaviors (Larsen, 1985). Teachers at high-achieving schools reported that the frequency of implementation by principals was significantly different from teachers at low-achieving schools. In both school types, teachers' perceptions of their principal's performance of leadership behaviors were lower than the principals' perception of self in implementing the specific instructional leadership behaviors (Larsen, 1985). The discrepancy in the survey data between teachers and principals was greater in low-achieving schools than in high-achieving schools. Interestingly, principals at high-achieving schools reported no difference in the frequency of implementation of leadership behaviors than principals at low-achieving schools (Larsen, 1985).

Heck, Larsen and Marcoulides (1990) researched the relationship between selected principal instructional leadership behaviors and student achievement. At the time of Heck et al.'s research, prior studies failed to precisely define instructional leadership and ensure a direct cause-and-effect relationship between the time spent focused on instructional leadership and increased student achievement. Heck et al. (1990) identified specific variables from the models developed by Pitner and Hocevar (1987) and Bossert, Dwyer, Rowan, and Lee (1982) to create their predictive theory model of principals' instructional leadership variables influencing student achievement. This model was developed to understand more thoroughly "how principals' behavior in various situational contexts affects school achievement" (Heck et al., 1990, p. 99). A sample of 332 teachers and 56 principals in California completed the Instructional Activity Questionnaire (Larsen, 1985) to assess the instructional leadership behavior of principals. Analysis of the survey results indicated that principal leadership behaviors within the school governance structure, school instructional organization, and school climate directly and indirectly influence student achievement.

Of the 22 variables featured in the survey, nine domains from Pitner and Hocevar's (1987) model applied to three indicators (governance function, school climate, and instructional organization) of Heck et al.'s (1990) predictive model, while two domains from Bossert et al.'s (1982) model were shown to be high indicators of principal instructional leadership. Principal instructional leadership at the elementary and high school levels rarely received high survey scores around leadership roles in curriculum and instruction, leading to school improvement. Heck et al.'s (1990) model reflected the establishment of a strong school climate and instructional organization as the principal's most significant role in affecting school achievement. The survey results revealed that the quality of specific leadership behaviors directly applies to high- and low-performing schools and is distinguished by each principal's belief in the importance of each behavior.

Additionally, Heck et al. (1990) determined that creating high expectations for academic achievement and social behavior, formal and informal discussions on instructional strategies, and maintaining faculty enthusiasm and morale were all critical variables of leadership promoting school climate. Leadership behaviors within the instructional organization domain reflected tremendous attention to developing school goals consistent with district aims, directly supervising instructional strategies through observation, and follow-up feedback to help teachers improve by promoting student achievement (Heck et al., 1990). Overall, the empirical research confirms that a causal relationship exists between principals' instructional leadership behaviors and school achievement based on the frequency and effectiveness of specific behaviors identified in Bossert et al.'s (1982) previous study.

Shaw, Doan, and Hale (1994) conducted a pilot study on Southwestern Alabama teachers' and administrators' perceptions of the importance of teaching science.

Teachers completed a brief one-page survey customized for instructors to collect demographic data with a five-point Likert-type scale to determine their perceptions of the importance of teaching science, while administrators completed a version intended for them. Shaw et al. (1994) found that of the participating teachers, 70% had been employed as teachers in their respective building positions for three or more years. Over 50% of the participating administrators had served their schools as principals for three or more years. The elementary teachers instructed science for about 50 minutes daily, with approximately half that time devoted to hands-on science activities. Middle school science teachers taught science for approximately 25 hours per week and devoted three hours per week to hands-on science activities. Shaw et al.'s (1994) data indicated that 60% of elementary and 100% of middle school principals perceived science as a "very important" subject in their schools. Elementary teachers (52%) and middle school teachers (78%) perceived the subject of science to be "very important." Interestingly, 55% of elementary and 47% of middle school teachers thought their principals perceived science to be "very important" (Shaw et al., 1994).

Research conducted by Painter and Valentine (1996) featured the use of the Instructional Practices Inventory (IPI) to identify the six types of teacher-student instructional engagement practices that were observed and documented through classroom observations. They include active learning/active teaching, teacher-led conversation, teacher-led instruction, student seatwork/teacher engaged, student seatwork/teacher disengaged, and total disengagement.

Quinn (2002) researched instructional leadership behaviors to identify their impact on teachers' instructional practices focused on active student engagement. Although past research on instructional leadership had been shown to influence instructional practices, none had explicitly identified what leadership style or approach by principals is effective across all school levels (Quinn, 2002). The findings provided evidence of a high correlation between principals' specific instructional leadership behaviors and teachers' specific instructional practices toward active engagement. Quinn’s (2002) study included 24 schools representing elementary, middle, and high school levels across Missouri's rural, suburban, and urban areas for this study. One-third of the teaching staff in each school building completed the Staff Assessment Questionnaire (SAQ) developed by Andrews and Soder (1987) to identify the four strongest domains of instructional leadership: resource provider, instructional resource, communicator, and visible presence.

The results of Quinn’s (2002) study revealed that principals who demonstrated instructional leadership behaviors as a resource provider, instructional resource, and active communicator impacted three of the instructional leadership practices of teachers: active learning/active teaching, student seatwork/teacher disengaged, and total disengagement. Quinn (2002) further explained that higher active teaching/active learning levels occurred in schools where the principal served as an instructional resource. Higher levels of student engagement were present in schools where the principal was rated highly as a resource provider. Higher levels of active learning/active teaching were present in schools where principals promoted communication. Quinn’s (2002) findings indicated no correlation between the other three instructional practices (teacher-led conversation, teacher-led instruction, and student seatwork/teacher engaged) and the leadership behaviors that existed. Additionally, there was no correlation between the fourth leadership behavior (visible presence) and any instructional practices.

Stein and Nelson (2003) explored how school and district leaders utilized content knowledge in their work as instructional leaders within various positions of authority. Three educational administrators were observed using a case study method. The administrators were interviewed about how their background knowledge and administrative training supported their work to influence teaching and learning in their schools. The administrators were an elementary principal performing formal observations on mathematics classes, an associate superintendent serving as chair of a mathematics curriculum selection committee, and a board of education administrative group conducting educational reform in mathematics and literacy in various areas of New York. The researchers specifically explored the knowledge that administrators needed to coordinate the activities that facilitate teaching and learning in the classroom (Stein & Nelson, 2003).

Within each leadership position, a general baseline of content knowledge in mathematics, how students learn the subject, and how the subject is taught was held by each professional; however, as the level of authority advanced, leadership content knowledge became thin (Stein & Nelson, 2003). The principal had the narrowest leadership responsibilities and was directly able to witness the influence instructional leadership had on how teaching was taking place in classrooms. The associate superintendent had less content knowledge in the subject area, which caused the inability to recognize ideas and topics of the elementary curriculum, as well as analyze the quality of instruction of the new curriculum to create “mathematical thinkers” instead of memorizers of facts and procedures (Stein & Nelson, 2003). The central office board could not identify the fundamental concepts about how mathematics and literacy work, the nature of argument and evidence within each subject, what knowledge and expertise teachers should possess for instruction in the subjects, and implications for what should happen in the classroom.

Overall, Stein and Nelson (2003) concluded that the level of content knowledge is different at the various levels of administration in education. Yet, instructional leadership responsibility for teaching and learning should be vested in at least one content area for more significant influence and effectiveness. Although unrealistic, Stein and Nelson (2003) also suggested that instructional leaders engage in “postholing”; engagement in deeper learning, training, and understanding of three or more content subjects to gain greater awareness of how knowledge is built-in; what learning tasks should look like; and what good instruction looks like in each subject.

From 1983 to 2005, 116 scholarly research studies were conducted on instructional leadership, reflecting increased interest in the topic. Hallinger (2005) highlighted the evolution of the three-dimensional role of principals in the instructional leadership model as researched over more than two decades. The three critical dimensions of Hallinger’s instructional leadership model are defining the school’s mission, managing instructional programming, and promoting positive school learning culture. Each dimension has been researched and studied over the years to examine and identify factors that influence educational administrators’ behaviors in displaying these skills. The first dimension explains the principal’s role in working with staff to create clear, measurable, timely academic goals for schools, teachers, and students. The second dimension addresses the communication, coordination, and collaboration of instruction and curriculum. The third dimension broadly defines the principal’s ability to model and support the values and practices of continuous improvement of a teaching and learning environment. Hallinger (2005) critiques the action taken by policymakers engaging in national educational reform on the leadership roles of principals referenced in multiple research studies and how this three-dimensional model creates heroic leaders who generally transform schools. Hallinger (2005) concluded that the study of principal leadership under this model was "meaningless without consideration for school contextual factors, such as student background, organizational structure, fiscal resources, or bureaucratic features of the school organization" (p. 234). Hallinger (2005) asserted, "Effective leaders respond to the changing needs of their context. Indeed, in a very real sense, the leader's behaviors are shaped by the school context" (p. 235).

Reflective leadership is viewed as one of the main qualities that school instructional leaders must possess to be effective, efficient, and productive (Ersozlu, 2016). A sample of 68 science teachers and 79 math teachers in high schools in Courm, Turkey participated in a study conducted by Ersozlu (2016). The purpose of the study was to determine the "reflective leadership levels of school principals" (p. 801) by determining the perceptions of the science and math teachers. Teachers working under such leadership were "the best judges of these qualities, especially math and science teachers, due to their high- level of numerical and critical thinking skills" (Ersozlu, 2016, p. 802). Using a reflective leadership scale, 15 questions were divided into three subcategories to identify leadership areas perceived by teachers: safe and open environment, purpose, and challenging assumptions.

A 5-point Likert-type scale was used for measuring the reflective scale responses ranging from strongly agree to strongly disagree. The total points of the study's response scale ranged from lowest (15 points) to highest (75 points), with a mean total of 56. Overall, the mean of the total responses showed a "highly positive correlation" between reflective leadership and the subcategories (Ersozlu, 2016, p. 805). Math teachers viewed the reflective leadership traits of principals higher than science teachers did. Ersozlu (2016) reported that teachers rated the reflective leadership trait of purpose as the highest, followed by a safe and open environment and challenging assumptions. Ersozlu also explored the perception of school principals' reflective leadership level based on teachers' age, gender, school level served, and years of experience, to which no significant difference was identified. Ersozlu (2016) indicated that "reflective leadership is closely correlated with transformation leadership in the literature" (p. 807).

The power of instructional coaching is grounded in the research-based principles of teacher learning. Desimone and Pak (2017) identified numerous researchers who have studied instructional leadership through professional development and the five critical features of teacher learning. In addition to the benefits of using this model for instructional coaching, Desimone and Pak highlighted the potential failures of each feature when the model was not attentively utilized. The five features presented were content focus, active learning, coherence, sustained duration, and collective participation.

Desimone and Pak (2017) provided evidence that "professional development experiences with an explicit focus on the content teachers are teaching in their classes have significantly impacted student learning in math, science, and language arts" (p. 5). Coaches with less content knowledge fail to build a teacher's pedagogical content knowledge. Active learning can take various forms, including active dialogue and feedback on observations, data analysis, and recorded lessons were most successful, with instructional coaches and teachers giving and taking during the learning process. To avoid a breakdown in the mentor-mentee relationship, Desimone and Pak warned against coaches becoming dictators of implementation and learning, causing teachers to rely on their encouragement of growth and improvement.

Desimone and Pak (2017) wrote “recent experiments provide evidence that having a substantial number of contact hours…students performed significantly better whenever their teachers experienced at least 14 hours of professional development” (p. 7). Instructional coaching through professional development cannot be a short-term engagement if the pedagogical content knowledge model is expected to succeed. Instructional leaders must protect the long-term planning for regular consultation, support, and analysis of teacher and student learning outcomes. Past research has revealed that collective participation in professional development groups is a highly effective method of creating positive learning environments for teachers to collaborate with “experts” on instructional challenges, shared vision and responsibility, and reconstructing teaching practices. While coaching can be conducted individually for new, struggling, and specific content area teachers, collaboration and shared learning enhance the effects of professional development. Finally, coherence ensures the alignment of content standards, curriculum, and critical elements of daily lesson planning during professional development training. Desimone and Pak (2017) declared

> Instructional coaching provides coherence through the coaches’ role in helping teachers navigate new instructional practices based on their prior held knowledge and beliefs about teaching . . . By serving as a thought partner or a counselor, coaches frame professional development or teachers in a way that is coherent to both their internal viewpoints and external expectations. (p. 8)

Unless subject-matter experts are staffed in schools, administrators and principals become coaches responsible for coordinating, supervising, and engaging in teacher professional development training due to their added roles as instructional leaders. This situation can be challenging for administrators with minimal background knowledge or content expertise in the subjects they are responsible for supervising.

Quebec Fuentes and Jimerson (2020) completed a research study examining how leadership-content knowledge (LCK) aids instructional leadership at the elementary, middle, and high school levels. Engagement in instructional leadership primarily focuses on classroom practice and promoting teacher professional development. Administrators may struggle with delivering instructional support when tasked with supervising or evaluating a broad span of teachers, designating time for observation, planning, and reflection with teachers. In addition, teacher-administrator relationships, quality of leadership actions, and limitations within the content knowledge and skills of administrators complicate school leaders' efforts to function as instructional leaders. Quebec Fuentes and Jimerson (2020) detailed the interview responses of 15 principals and 16 teachers working in various Texas school districts. Interviews specific to either teachers or school leaders dealt with "the nature of feedback received or provided by the participant within formal or informal supervision or evaluation processes and probed for examples of feedback in instances of content area/grade level match or mismatch between school leaders and teacher" (Quebec Fuentes & Jimerson, 2020, p. 11). Instructional matching is described as pairing teachers and school leaders whose professional backgrounds (i.e., grade level, content area, teaching experience) partner or are equal for the supervision and support of teaching and instruction. The instructional mismatch is the pairing of teachers and school leaders with no compatible factors. The study findings revealed that 10 of 16 teachers "reported receiving feedback from a school leader in the context of instructional matches during their careers. In contrast, 15 of the 16 teachers reported evaluative interactions with school leaders who were instructional mismatched" (Quebec Fuentes & Jimerson, 2020, p. 11). However, "12 of the 15 school leaders described supervising teachers who shared content and/or grade level expertise. In contrast, 14 of the 15 described regular engagement with teachers in areas of instructional mismatch" (Quebec Fuentes & Jimerson, 2020, p. 11). Overall, analysis of interview data caused researchers to conclude how instructional leadership and LCK intersect. The teachers' responses described factors they believe to be foundational to instructional leadership efforts: establishing constructive teacher-leader relationships through presence, empathy, and understanding and contributing to teacher professional growth through timely, pedagogical-content knowledge feedback.

Quebec Fuentes and Jimerson (2020) reported that the efforts and approaches of school leaders were classified under two categories: school leader roles and types of leadership feedback. Five school leader roles identified were monitor, cheerleader, broker, co-learner, and coach. Researchers declared "The role of the school leader as a co-learner seemed to be a viable pathway for leaders aiming to build LCK," and coaching approaches were thus enhanced when the leader could draw upon LCK (Quebec Fuentes & Jimerson, 2020, p. 20). Additionally, Quebec Fuentes and Jimerson (2020) indicated that "types of feedback ranged from absence to one-way, atmospheric, crossover, and PCK-focused**" (**p. 17). Many of the school leaders reported that the nature of their feedback "varied depending on their content area or grade level expertise" (Quebec Fuentes & Jimerson, 2020, p. 22). The "focus of leaders' feedback to teachers was often situational, most often due to school leaders' inability to speak to deeper issues of content-related pedagogy" (Quebec Fuentes & Jimerson, 2020, p. 21). Of 18 instances of atmospheric feedback being facilitated, only two were used in the context of an instructional match; 16 were in conjunction with descriptions of instructional mismatch.

Leaders who acknowledged degrees of discomfort with content talked about providing feedback related to atmospheric and crossover practices in contexts of "instructional mismatch," which poses substantial challenges to the leaders' ability to advise secondary mathematics and science teachers (Quebec Fuentes & Jimerson, 2020, p. 24). Balancing efficiency and effectiveness within types of feedback delivered by instructional leaders consists of creating efficiency routines, building constructive and trusting relationships with teachers, and building instructional credibility. Quebec Fuentes and Jimerson (2020) noted that "leaders who acknowledged instructional limitations talked about mitigating instructional mismatch by enacting a role of broker of professional learning" and embracing distributed leadership to work beside teachers to build LCK and increase efficacy as an instructional leader (p. 26). To make meaningful changes in classroom practice, instructional leaders must strategically utilize time for reflection and focus on how their range of or lack of leadership content knowledge shapes the feedback they provide to teachers to meet their needs. Furthermore, Quebec Fuentes and Jimerson (2020) added attention to leadership preparation programs, professional learning networks, and professional development programs can help identify and eliminate the nuances of how school leaders build knowledge for successful instructional leadership.

Content Knowledge Leadership

Burch and Spillane (2003) researched the relationship between elementary school principals and subject matter, specifically how leaders view specific subjects and how those views influence the behavior and practice of leadership supervising curriculum instruction and reform. Fifteen elementary school administrators (principals and assistant principals) and 15 curriculum coordinators serving in eight urban elementary schools in a

Chicago school district were observed, interviewed, and videotaped to document administrators' specific professional views, instructional leadership, and reform choices in mathematics and literacy. The researchers focused on four areas of interest: influence of teachers' subject matter views on teacher work, distribution of instructional leadership within schools, reciprocal relations between social structures and human agency, and the role of sense-making in human cognition.

Burch and Spillane (2003) reported that elementary school leaders viewed mathematics and literacy as core subjects but held different instructional priorities for each. Of all the instructional leaders who participated in the study, 87% of principals reported engaging with literacy teachers daily about instruction and curriculum reform. In comparison, 60% of curriculum coordinators reported having daily engagement with mathematics teachers on the same topics. The types of support and resources for both subjects differed significantly. Mathematics was viewed as a highly defined subject matter. The best resources used to develop expertise and instructional reform in mathematics come from outside schools, such as new curriculum textbooks and instructional materials, professional development training, and workshops. Among the research results, Burch and Spillane identified leadership views needed by school leaders for instructional support of teachers to enhance their expertise and improve student achievement within their schools that were neglected. Building teachers and staff were viewed by leadership as the greatest literacy experts in instruction and reform, regardless of their depth of professional training, development, or knowledge of best practices due to the broad practicality of the curriculum across all other subjects. Support for literacy teachers consisted mainly of classroom observations, direct feedback from administrators and curriculum coordinators, and informal roundtable discussions with other teachers.

Ultimately, elementary school principals and curriculum coordinators would greatly benefit from engaging with teachers to gain new, more meaningful perspectives about what teachers offer and what they need to expand their expertise and make improvements in mathematics and literacy instruction. Burch and Spillane showed that ideas and routine practices that school administrators perceive to be subject-specific greatly influence the leadership practices, challenges, supports, and reform actions for instructional leadership. Examining how subject matter views are acted out and shift within instructional and school administration is very important to improvement.

Chance and Anderson (2003) studied how statewide science curriculum reform was perceived to impact the primary areas of instructional leadership, including curriculum, assessment, accountability, professional development, and supervision. Their findings highlighted a tremendous difference in perception between secondary principals' and teachers' perceptions. Surveys were completed by 149 secondary science teachers and 56 secondary administrators serving 43 schools across the state of Nevada. Additionally, random telephone interviews were used to collect data about the new Nevada science standards' influence on instructional leadership and supervision. Chance & Anderson (2003) contend that "since effective and high-achieving schools depend upon capable instructional leadership from the principal, instructional leadership and supervision are essential elements for facilitating learning and promoting new, innovative school practices, as with curriculum reform" (p. 3).

Over 73% of administrators agreed or somewhat agreed that the science standards positively impacted the science curricula, provided common expectations, guided lesson planning, allowed teachers to stress teaching and learning, and provided shared expectations for students (Chance & Anderson, 2003). However, 68% of the science teachers agreed or somewhat agreed that the standards guided lesson planning and provided shared expectations for students. Only 39% of the science teachers agreed or somewhat agreed that the standards emphasized teaching and learning (Chance & Anderson, 2003). Furthermore, 77% of the administrators and 46% of science teachers perceived the science standards positively impacted science instruction. There were significant differences between administrators' and teachers' perceptions related to the impact of the standards on assessment, accountability, professional development, and curriculum (Chance & Anderson, 2003).

Regarding the impact of the Nevada Science Standards on principal instructional leadership behavior, significant differences were found between science teachers' and administrators' responses to all questionnaire items. Chance and Anderson (2003) pointed out that "administrator responses indicated that the majority perceived they were active in the functions that define instructional leadership. Eight of 14 questionnaire items had a response frequency for participating administrators with 90% or higher favorable (either agree or somewhat agree)" (p. 23). Of the participating teachers, 37% of teachers positively perceived the impact of assisting with classroom supervision and the focus of teacher evaluation conferences performed by principals. However, 60% of high school administrators perceived the result as positive on their instructional leadership behaviors.

Administrators reported strong engagement in encouraging teacher reflective behavior, promoting professional dialogue among science teachers, promoting professional growth among teachers, soliciting teacher's advice and opinions about classroom science instruction, and supporting science teachers' efforts for classroom innovations which overall encouraged teachers to take primary responsibility for implementing science standards in the classroom (Chance & Anderson, 2003). Based on study results, administrators were perceived as supervisors of science education reform instead of facilitators of the process to enhance the teaching and learning of the new science standards. What principals saw as leading, coaching, encouraging, and supporting were not viewed that way by teachers. Chance and Anderson's (2003) study results reflected that science teachers and administrators differed greatly in their perceptions of the impact of the Nevada science standards on all six areas of instructional leadership. Teachers and principals reported that they perceived teachers to hold greater accountability for student achievement than principals. Additionally, principals viewed the science standards as having a greater impact on curriculum and instructional practices than teachers did (Chance & Anderson, 2003)

Yehuda, Yael, and Yehudit (2011) conducted research on the reform of science and technology education in Israel. Teachers participating in a two-year professional development project to implement information communication technology (ICT) curriculum and instruction at the junior high school level were tracked and interviewed over seven years. Yehuda et al. (2011) focused on the long-term effect of junior high school principals' attitudes on teachers' approach to collaboration, development of new ideas and classroom practices, and their abilities to assimilate online web-based teaching influenced the outcomes for success. Four types of principals were identified based on characteristics of support for teachers in the ICT professional development program: initiating, empowering, permitting yet preventing, and resisting. Teachers were also classified into four types: initiator/pathfinder, follower/conformist, evader, and objector/antagonist (Yehuda et al., 2011). During the study, all principals remained constant in their support classification type provided to their teachers; however, significant changes in the teacher classification type of those working with empowering principals occurred. During the first two years of the study, teacher classification types slightly regressed under the influence of empowering principals, but five years later, those teachers experienced a positive shift in classification; objector and evader teachers shifted toward follower and initiator types (Yehuda et al., 2011).

Lochmiller et al.'s (2012) literature review on principal instructional leadership identified recurring critical findings on the general subject, followed by a suggestion of alternative leadership preparation programs specific to the subject matter to improve principals' instructional leadership performance. Lochmiller et al. pointed out "that students in the United States are not performing in math and science, as proficiently as their global peers" likely due to teaching and learning factors (p. 200). Due to the relationship between instructional leadership and improved student learning, principals can heavily influence teaching and learning in schools. However, leadership preparation programs do not adequately prepare administrators to lead improvements, especially in content-specific areas such as math and science (Lochmiller et al., 2012). The researchers identified the characteristics of principals necessary for leadership in math and science instruction as supporting the relationship between pedagogy and content knowledge for improved student learning, adopting or using project-based learning, collaborating across disciplines, investing in and leveraging resources, and developing relationships between administrators, teachers, and students. Lochmiller et al. purported that a sharp focus on each of these characteristics is missing from current principal leadership training programs.

Lochmiller and Acker-Hocevar (2016) studied how principals leverage their skills to influence and make sense of content knowledge leadership. By conducting interviews with over 20 high school administrators working in the western region of the United States, Lochmiller and Acker-Hocevar focused on math and science content knowledge leadership for support and response to improved instruction and practices by classroom teachers in these areas. The findings of the study revealed that the participating high school administrators perceived themselves to lack knowledge in math and science content, which prevented them from engaging in instructional improvement issues with teachers. As a result, the administrators actively exercised leadership resources, strategies, and behaviors that empowered teachers to support instructional improvement for themselves without having to expand their math and science content expertise. These administrators commonly responded to instructional challenges from an operational position, such as creating opportunities for teachers to collaborate, hiring teachers and professionals who successfully modeled effective instruction and promoted collaborative improvement, and investing resources in external professional development training. These acts of leadership made sense to the administrators, given their content area deficiencies and assessment of relationships within content departments. The findings of this study present a contradiction to past research literature that had defined a close relationship between instructional leadership and subject matter. Still, administrators may engage in instructional leadership differently across content areas, and their differences may relate to their understanding of the content area. Lochmiller and Acker-Hocevar (2016) suggested that principals identify potential barriers to improvements in content areas, create alternative strategies to improve instruction, and leverage strategies to improve teaching.

Williams (2019) purported that assistant principals depend on their principals' leadership to develop their capacity to perform instructional leadership effectively. In

Duval County Public Schools in Jacksonville, Florida, 34 middle and high school assistant principals were surveyed and interviewed about their perceptions of development as instructional leaders based on the actions and practices of the head principals in their schools. Little research on the selection, training, professional development, and support of assistant principals had been conducted prior to this, prompting further exploration of how instructional leadership can be developed effectively and efficiently (Williams, 2019). Under the theory of transformational leadership, principals must intentionally develop and monitor meaningful opportunities for assistant principals to develop instructional leadership tools and skills to affect change in schools. Williams' (2019) study participants shared four perspectives of development: relational and support, coaching and collective collaboration, data-focused feedback, and professional development and strategic planning. Assistant principals emphasized the importance of relationships and support between administrators as the highest priority of leadership development (Williams, 2019). Coaching and collective collaboration center around the coaching, mentoring, and teamwork approach within instructional leadership toward school goals and transformative action (Williams, 2019). The data-focused and feedback perspective is grounded in data analysis that supports decision-making and school improvement efforts on an ongoing basis (Williams, 2019). Lastly, the professional development and strategic planning perspectives shared by assistant principals represent the specialized training and planning for implementation required to become an instructional leader (Williams, 2019). These perspectives add depth to the assistant principal position by becoming competent, resourceful professionals with the capacity to be instructional leaders in their administrative position (Williams, 2019).

Furthermore, Williams (2019) described four perspectives (relational & support, coaching & collective collaboration, data-driven & feedback, and professional development & strategic planning) that may assist district administrators and building principals in how assistant principals can be thoroughly developed and adequately trained towards instructional leadership. While they may not become experts in all facets of each theme, it is necessary for assistant principals to gain experience and understand the importance of all perspectives as it relates to their overall development as an instructional leader. This experience and knowledge can be applied and cultivated via a rigorous, hands-on, and ongoing professional instructional leadership development program. With this new frame of instructional leadership development, professional development must be refined to meet the needs of schools as it pertains to assistant principals.

Engagement in Leadership Practices in Science

Winn (2016) researched if elementary principals' backgrounds and experiences in science were related to their levels of self-efficacy and instructional leadership in science. The researcher investigated the instructional practices, content knowledge, and self-efficacy of 667 elementary school principals in science for states that adopted the NGSS curriculum (Arkansas, California, Illinois, Iowa, Kansas, Kentucky, Maryland, Nevada, New Jersey, Oregon, Rhode Island, Vermont, and Washington). Past researchers determined that the NGSS curriculum guide challenges existing leadership theories, often promoting a "generalized pedagogical approach to instructional leadership that could theoretically be applied to any content area" (Winn, 2016, p. 121). The challenges that accompany the implementation of NGSS need to be acknowledged and appreciated so school leaders can appropriately address the science-specific needs of their elementary teachers (Winn, 2016). The focus on elementary principals' demographics, professional and academic backgrounds, self-efficacy, and leadership behaviors identified the potential for instructional leadership in science.

Gender and race are demographic factors that have been proven meaningful in STEM educational and professional representation when there is a disparity between men and women and whites and people of color (Winn, 2016). Gender, race, and earning a science or STEM degree were not significant predictors of instructional leadership practices for science in this study. Of the study participants, 21% of elementary principals earned a degree in a science-related field; however, 79% of the participants did not have any formal science degree nor high-level training in science content knowledge. Approximately 13% of the participants were previous science-only teachers, and over 11% indicated that they had never taught a science lesson. Additionally, 64% of the participants reported that the last time they conducted a science lesson was more than five years ago. Participants in the study with more years of classroom teaching experience and more years of administrative experience correlate positively with instructional leadership behaviors. Winn (2016) declared

> Experience working as a science teacher is a significant predictor of instructional leadership- authentic experience in, familiarity with, and responsibility for teaching science are related to principals' commitment to instructional leadership practices…The recency of science instruction is a statistically significant factor in predicting science leadership, but a large majority of principals do not have recent experience teaching science. (p. 105)

Still, most participants did not have recent experience teaching science (Winn, 2016). Only 15% of principals have taught a science lesson since the NGSS became available for adoption. There is a positive relationship between the recency of science teaching and instructional leadership and between principals who served as strictly science teachers before assuming their administrative role and instructional leadership. Suburban settings and the number of teachers to supervise reflected negative correlations with instructional leadership that could be explainable by logistics (school size, support resources, and time for classroom visits) (Winn, 2016).

Bandura's (1989) triad regression model focused on self-efficacy (specific professional experiences) in predicting principals' instructional leadership behaviors in science accounted for approximately one-third of the total explained variance of the predictors of instructional leadership. Principals with higher scores in science self-efficacy tended to engage in the measured concrete science leadership practices, suggesting that confidence in science can impact leadership in science. Winn (2016) asserted

> There were numerous principals in this sample who reported they do not have experience exclusively as a science teacher, nor recent experience teaching a science lesson. Despite subject-specific inexperience, the organizational expectation of their position demands that they are still responsible for leading in science. Teaching science may not be an option for all those entering the principalship, and therefore alternative strategies areas to increase their leadership capacity for science are potentially necessary. (p. 127)

Throughout the study, cognitive and personal factors such as race and gender were identified as insignificant factors on instructional leadership behaviors in science until applied to the regression model. Black principals serving in urban settings showed a significant and positive predictor of instructional leadership in science, responding to accountability expectations and taking a proactive and hands-on approach to science leadership (Winn, 2016). As with the case of the suburban school settings, organizational factors impacting the role of school leaders include those characteristics of their professional environments and the policy contexts in which they are situated. This research finding suggests that either principals did not engage in frequent science leadership practices even as their school implemented the NGSS, or schools had not yet begun to implement the adopted NGSS and thus did not demand high levels of hands-on principal support for instructional development (Winn, 2016).

McNeill, Lowenhaupt, and Katsh-Singer (2018) investigated K-8 principals' perceptions of "good science instruction" and their abilities to analyze classroom videos in relation to science practices (p. 452). The researchers interviewed 25 principals serving in kindergarten through eighth-grade schools from the northeastern region of the U.S. to assess principals' understanding of the science practices for schools implementing the NGSS. More specifically, researchers focused the interviews on principals' knowledge of the NGSS practices of investigating, sensemaking, and critiquing and their exercise of instructional leadership and supervision in these areas.

The study's findings revealed that principals needed substantial support to serve as influential instructional leaders of science. Not only did they need to develop their understanding of effective science instruction, but they also needed help building the capacity to "notice" the science practices (McNeil et al., 2018). Nearly all the principals in the study described good science instruction as being hands-on, though they had different meanings of what counted as hands-on. When videos of science classroom instruction were observed and critiqued by principals, their comments were very general regarding what the principals noticed and provided feedback. Observations focused on general pedagogy with very few remarks about the quality of science practices, disciplinary core ideas in the teacher talk, student talk, instructional activities, or classroom representations, but rather general aspects such as the configuration of the room, the gender of the students participating, or the engagement level of the students.

Instructional leaders need professional learning experiences to support their understanding of science practices. The principals' responses suggest that they hold similar views of good science instruction, focusing on investigations without understanding the sensemaking or critiquing science practices. Of the responding principals, 77% indicated investigating practices as being necessary for science classrooms. Sensemaking practices (38%) and critiquing practices (12%) were identified as much less prevalent. Supporting principals' understandings of the impact of using the three science categories in science instruction in a usable and scalable way might support more significant systematic reform than an approach that relies solely on science teachers and their students (McNeil et al., 2018).

Lowenhaupt and McNeill (2019) examined the science-specific instructional leadership of K-8 administrators in Massachusetts. With the implementation of NGSS, the instructional support of school administrators was needed due to the shift in teaching and learning for Grades K- 8. Although a common understanding about distinguishing the difference in instruction between subject matter and curriculum exists, no attention has been given to those differences when evaluating instructional leadership within instructional reform. Although data was collected from a small sample of 26 school principals from six school districts, the study results provided insight into the potential impact of principals' supervision perceptions on teacher learning and the influence on meeting the goals of NGSS. The findings revealed that the principals provided minimal science supervision, content-neutral leadership, and in most cases, lacked any background knowledge to support traditional or NGSS science teaching and learning.

Additionally, Lowenhaupt and McNeill (2019) reported that all study participants viewed science as a valuable subject, and 62% of the participants reported that they did not prioritize science as a subject for supervision. Formal observations of science classrooms were rare, and the teacher evaluation system featured minimal supervision practices such as goal setting or teacher observation and feedback. The pressures for school achievement and district performance on state assessments lead to prioritizing mathematics and literacy instruction, taking precedence over science and limiting the time for teaching, specifically in earlier grades. Of the participating principals, 96% reported supervising science instruction using a "content-neutral" approach that emphasized the general aspects of education and learning rather than content-specific support because "they simply did not know how to provide content-specific feedback" (Lowenhaupt & McNeill, 2019, p. 472). Features of instruction that reflected "good teaching" for a generic curriculum were highlighted because 88% of the participants without a background in science or who had not engaged in science learning opportunities admitted to a lack of confidence to support the subject. Over 75% of the participants also identified the need for a greater focus on science to build capacity among supervisors and teachers. Establishing a set of best practices for K-8 supervision of science was recommended to understand that applying content-specific understanding is a necessary component of effective leadership. Educational leaders need to understand the specific features of good science teaching and discontinue the content-neutral approach to supervision.

Summary

The limited amount of research studying instructional leadership in K-12 science education compared to the information available regarding instructional leadership overall is meaningful. Existing research has the potential to suggest that interests in public school leadership, teaching, learning, and achievement within science education are not important. From the research that has been conducted on engagement in instructional leadership in science education, a lack of training, support, and practice has been shown by school administrators working with their former science curriculums. Chapter 3 includes the research design, selection of participants, measurement, data collection, data analysis and hypothesis testing, and the limitations.

Chapter 3

Methods

The purpose of this study was to determine the extent middle school administrators report engagement in leadership practices for science instruction, including setting goals, supervising, coordinating resources, evaluating, establishing staff development, establishing school climate, and developing school/community relations. An additional purpose of this study was to determine the extent gender, years of teaching experience, and years of administrative experience influence middle school administrators' reported engagement in leadership practices for science instruction. This chapter provides a description of the components of the study's methods. Chapter 3 includes the research design, selection of participants, and measurement. Furthermore, provided in the chapter is information about the data collection process, data analysis and hypothesis testing, and the limitations.

Research Design

A quantitative descriptive design using survey methods was applied in this study. Lunenburg and Irby (2008) noted that the descriptive research design is about the perception of the phenomena being researched from the viewpoint of survey participants. The dependent variables in this study were the administrators' perceptions of engagement in instructional leadership behaviors and practice in science. The independent variables in this study were the participant's gender, years of teaching experience, and years of administrative experience.

Selection of Participants

The population for this study was public middle school administrators (principals and assistant principals) in Kansas during the 2021-2022 school year. Using the KSDE directory, all active middle school administrators in Kansas with valid email addresses were contacted to participate in the study. The middle school administrators who chose to complete the survey comprised the sample.

Measurement

Creswell (2008) recommended the selection of good and appropriate subscales that best fit the research goals, are used by other researchers in the field, and are reviewed in the literature as appropriate instruments and acceptable measures of reliability and validity. The Instructional Activity Measurement Subscale was used for this research due to its applicability to the study's research questions. This instrument is an 11-question subscale survey developed by Larsen (1985) and modified by Heck et al. (1990) to examine the leadership behaviors of administrators. Heck granted permission for this subscale of the survey to be used and modified to meet the purposes of this study (see Appendix A).

Larsen's (1985) Instructional Activity Measurement Survey was developed with the help of a panel of educational experts to determine the validity of the survey. The panel consisted of 10 nationally known education professionals who possessed at least four out of five qualifying characteristics: (a) an advanced degree, (b) responsibilities in instructional leadership in their current work field position, (c) national publication regarding instructional leadership in the past five years, d) development of instructional leadership model, and e) research or training experience with school principals related to instructional leadership in the past five years. Larsen reviewed past research on instructional leadership behaviors believed to consecutively impact student achievement, generating a list of 44 specific, identifiable behaviors for consideration by the panel. A questionnaire asking the panel to rate the 44 behaviors by degree of importance on a

Likert-type five-point scale (5 - "very important," 3 - "important," 1 - "unimportant") was submitted to the expert panel. A mean score was calculated for each behavior Larsen's study identified, resulting in an average mean of 3.87. Data analysis of the 44 behaviors reflected that 29 behaviors scored a mean rating or higher and thus were used to create the finalized version of the Instructional Activity Measurement Survey. Heck et al. (1990) modified Larsen's (1985) survey to include the 22 most important instructional leadership behaviors of principals, which were categorized into leadership functions: governance (4 behaviors), school climate (7 behaviors), and instructional organization (11 behaviors). These categories were developed to predict how each factor influences student achievement from the school leadership perspective. For the current study, only the 11 behaviors associated with instructional organization were utilized.

For the Instructional Activity Measurement Survey utilized in this study, a Likert-type scale (1 = *never*, 2 = *rarely,* 3 = *sometimes*, 4 = *frequently*, 5 = *always*) was used to measure the variables specified in the research questions regarding the perceptions of Kansas public middle school administrators' engagement in instructional leadership practices in science. The instructions included at the top of the survey specifically asked the participants to respond to each survey item as it related to science teaching and learning (see Appendix B). Table 2 presents each survey item with the corresponding hypotheses for this study.

Table 2

Survey Items Linked to Hypothesis Statements

Survey Item	Hypotheses
I ensure that school instructional goals for science are developed congruently with district policies.	H1, H12, H23, H34
I work with teachers to coordinate the science instructional program between grades.	H2, H13, H24, H35
I participate in formal and/or informal discussions concerning science instruction as it impacts student achievement.	H3, H14, H25, H36
I systematically observe teachers' science instructional methods within the classroom.	H4, H15, H26, H37
I ensure systematic procedures for monitoring student progress in science classes are utilized by staff.	H5, H16, H27, H38
I place emphasis on the meaning of test results for science program improvement.	H6, H17, H28, H39
I assist science teachers in securing available resources for program implementation.	H7, H18, H29, H40
I make regular visits to science classrooms.	H8, H19, H30, H41
After observation, I systematically help science teachers improve their effectiveness.	H9, H20, H31, H42
I identify science faculty in-service needs.	H10, H21, H32, H43
I evaluate science curricular programs.	H11, H22, H33, H44
Gender	H12-H22
Teaching experience	H23- H33
Administrative experience	H34- H44

Evaluating the reliability of measurement is a process conducted to ensure the accuracy, reproduction, and consistency of research measurements and responses. Assessment methods must be consistent in their ability to be duplicated, responses in various test environments, and repeated scoring measures. Conducting a reliability analysis prior to conducting live research helps avoid errors, predictable or chance, to produce true data scoring. A reliability analysis was not needed for this study because a scale was not constructed from the survey items. The researcher used single-item measurement.

> Most used single-item measures can be divided into two categories: (a) those measuring self-reported facts... and (b) those measuring psychological constructs, e.g., aspects of personality... Measuring the former with single items is common practice. However, using a single-item measure for the latter is a "fatal error" in research. If the construct being measured is sufficiently narrow or is unambiguous to the respondent, a single item may suffice. (Sackett & Larson, 1990, p. 631)

The individual items used in this research were self-reported facts that were sufficiently narrow and unambiguous. Therefore, reliability was not an issue for the measurement using this survey instrument.

Data Collection Procedures

Before data was collected for the current study, the Baker University Institutional Review Board (IRB) approved the request to conduct the study on January 7, 2022 (see Appendix C). The survey was distributed via email on March 1, 2022, requesting the selected sample to participate in the study (see Appendix D). The email included information about the purpose of the study, the researcher's contact information, and notification that participation would be voluntary. Participants were told in the email that by completing the survey, the participants were giving their consent for their responses to be used in this study. Additionally, participants were encouraged to complete the survey as all submissions were anonymous throughout the survey window and time available for completion. Two additional email reminders were sent on March 22, 2022, and April 5, 2022 (see Appendix E). Once the survey was closed on April 15, 2022, data from Google Forms were downloaded to an Excel spreadsheet. The downloaded data were imported into IBM SPSS Statistics Faculty Pack 26 for Windows for analysis.

Data Analysis and Hypothesis Testing

Each of the research questions is listed below, followed by the 11 hypotheses tested to address each question. After the list of hypotheses, a paragraph describing the analyses used to test each set of hypotheses for each research question is included.

RQ1. To what extent do middle school administrators perceive they are engaged in leadership practices for science instruction?

H1. Middle school administrators perceive that they frequently or always ensure that school instructional goals for science are developed congruently with district policies.

***H2*.** Middle school administrators perceive that they frequently or always work with teachers to coordinate the science instructional program across grades.

***H3*.** Middle school administrators perceive that they frequently or always participate in formal and/or informal discussions concerning science instruction as it impacts student achievement.

***H4*.** Middle school administrators perceive that they frequently or always systematically observe teachers' science instructional methods within the classroom.

***H5*.** Middle school administrators perceive that they frequently or always ensure systematic procedures for monitoring student progress in science classes are utilized by staff.

H6. Middle school administrators perceive that they frequently or always place emphasis on the meaning of test results for science program improvement.

H7. Middle school administrators perceive that they frequently or always assist science teachers in securing available resources for program implementation.

H8. Middle school administrators perceive that they frequently or always make regular visits to science classrooms.

H9. Middle school administrators perceive that they frequently or always, after observation, systematically help science teachers improve their effectiveness after observing.

H10. Middle school administrators perceive that they frequently or always identify science faculty in-service needs.

H11. Middle school administrators perceive that they frequently or always evaluate science curricular programs.

Eleven one-sample *t* tests were conducted to test H1-H11. The sample means for middle school administrators' perceptions of the frequency they engage in leadership behaviors were compared to a test value of 3. The one-sample *t* test was chosen for the hypothesis testing because it involves a comparison of one group mean with a known value, and the group mean is calculated from a numerical variable. The level of significance was set at .05. When appropriate, the effect size, as indexed by Cohen's *d,* is reported.

RQ2. To what extent does gender influence middle school administrators' perceived engagement in leadership practices for science instruction?

H12. Middle school administrators' perceptions that they frequently or always participate in the development of school goals for science are affected by gender.

H13. Middle school administrators' perceptions that they frequently or always coordinate the science instructional program with teachers across grade levels for science are affected by gender.

H14. Middle school administrators' perceptions that they frequently or always hold formal/informal discussions of science instruction are affected by gender.

H15. Middle school administrators' perceptions that they frequently or always observe science teachers' instructional methods are affected by gender.

H16. Middle school administrators' perceptions that they frequently or always ensure systematic monitoring of student progress in science class by staff are affected by gender.

H17. Middle school administrators' perceptions that they frequently or always emphasize test results for science program involvement are affected by gender.

H18. Middle school administrators' perceptions that they frequently or always secure resources for science programs are affected by gender.

H19. Middle school administrators' perceptions that they frequently or always make regular science class visits are affected by gender.

H20. Middle school administrators' perceptions that they frequently or always help science teachers improve effectiveness after observing science classes are affected by gender.

H21. Middle school administrators' perceptions that they frequently or always identify in-service needs for science instruction are affected by gender.

H22. Middle school administrators' perceptions that they frequently or always evaluate science curricular program are affected by gender.

Eleven independent-samples *t* tests were conducted to test H12-H22. Male and female middle school administrators' perceptions of the frequency they engage in leadership practices for science instruction were compared. An independent-samples *t* test was chosen for the hypothesis testing because the hypothesis tests involve the examination of the mean difference between two mutually exclusive independent groups (male and female middle school administrators), and the means are calculated using data for numerical variables. The level of significance was set at .05. When appropriate, an effect size, indexed by Cohen's *d*, is reported.

RQ3. To what extent does the number of years of teaching experience influence middle school administrators' perceived engagement in leadership practices for science instruction?

H23. Middle school administrators' perceptions that they frequently or always participate in the development of school goals for science are affected by their years of teaching experience.

H24. Middle school administrators' perceptions that they frequently or always coordinate the science instructional program with teachers across grade levels are affected by their years of teaching experience.

H25. Middle school administrators' perceptions that they frequently or always hold formal/informal discussions of science instruction are affected by their years of teaching experience.

H26. Middle school administrators' perceptions that they frequently or always observe science teachers' instructional methods are affected by their years of teaching experience.

H27. Middle school administrators' perceptions that they frequently or always ensure systematic monitoring of student progress in science class by staff are affected by their years of teaching experience.

H28. Middle school administrators' perceptions that they frequently or always emphasize test results for science program involvement are affected by their years of teaching experience.

H29. Middle school administrators' perceptions that they frequently or always secure resources for science programs are affected by their years of teaching experience.

H30. Middle school administrators' perceptions that they frequently or always make regular science class visits are affected by their years of teaching experience.

H31. Middle school administrators' perceptions that they frequently or always help science teachers improve effectiveness after observing science classes are affected by their years of teaching experience.

H32. Middle school administrators' perceptions that they frequently or always identify in-service needs for science instruction are affected by their years of teaching experience.

H33. Middle school administrators' perceptions that they frequently or always evaluate science curricular program are affected by their years of teaching experience.

Eleven one-factor analyses of variance (ANOVAs) were conducted to test H23-H33. The categorical variable used to group the dependent variable, middle school administrators' perceptions of the frequency they engage in leadership practices for science instruction, was years of teaching experience (1-3 years, 4-6 years, 7-10 years, 11-14 years, 15 or more years). The results of the one-factor ANOVA can be used to test for differences in the means for a numerical variable among three or more groups. The level of significance was set at .05. When appropriate, an effect size, as indexed by eta-squared, is reported.

RQ4. To what extent does the number of years worked in administrative positions influence middle school administrators' perceived engagement in leadership practices for science instruction?

H34. Middle school administrators' perceptions that they frequently or always participate in the development of school goals for science are affected by their years of worked in administrative positions.

H35. Middle school administrators' perceptions that they frequently or always coordinate the science instructional program with teachers across grade levels are affected by their years of worked in administrative positions.

H36. Middle school administrators' perceptions that they frequently or always hold formal/informal discussions of science instruction are affected by their years of worked in administrative positions.

H37. Middle school administrators' perceptions that they frequently or always observe science teachers' instructional methods are affected by their years of worked in administrative positions.

H38. Middle school administrators' perceptions that they frequently or always ensure systematic monitoring of student progress in science class by staff are affected by their years of worked in administrative positions.

H39. Middle school administrators' perceptions that they frequently or always emphasize test results for science program involvement are affected by their years of worked in administrative positions.

H40. Middle school administrators' perceptions that they frequently or always secure resources for science programs are affected by their years of worked in administrative positions.

H41. Middle school administrators' perceptions that they frequently or always make regular science class visits are affected by their years of worked in administrative positions.

H42. Middle school administrators' perceptions that they frequently or always help science teachers improve effectiveness after observing science classes are affected by their years of worked in administrative positions.

H43. Middle school administrators' perceptions that they frequently or always identify in-service needs for science instruction are affected by their years of worked in administrative positions.

H44. Middle school administrators' perceptions that they frequently or always evaluate science curricular program are affected by their years of worked in administrative positions.

Eleven one-factor ANOVAs were conducted to test H34-H44. The categorical variable used to group the dependent variable, middle school administrators' perceptions of the frequency they engage in leadership practices for science instruction, was years of administrative experience (1-3 years, 4-6 years, 7-10 years, 11-14 years, 15 or more years). The results of the one-factor ANOVA can be used to test for differences in the means for a numerical variable among three or more groups. The level of significance was set at .05. When appropriate, an effect size, as indexed by eta-squared, is reported.

Limitations

Lunenburg and Irby (2008) stated, "Limitations of a study are not under the control of the researcher" (p. 133). Any limitations in this research study can impact the results of the study in a variety of ways: the need for greater research sample participation, alternative methods of study survey or assessment, or duplicate participant responses. These boundaries should be considered prior to conducting live research to eliminate any possibilities of error or invalidity in data. The limitations of this study include the following:

1. Administrators may have chosen to decline the invitation to participate in the study.
2. Administrators may not have received the invitation to participate because email settings on their district internet servers might have moved the email to junk mail.
3. A low response rate from the selected sample would be a direct result of limitations 1 and 2.
4. The frequency of specific leadership behaviors was measured, but no determination of the quality or effectiveness of the practices can be made.

Summary

In this chapter, the methodology used to conduct this study on Kansas middle school administrators' perceptions of engagement in instructional leadership in science was described. Included in this chapter were the research design, the selection of participants, measurement, the data collection procedures, and the data analysis and hypothesis testing. Finally, the limitations of the study were addressed. Chapter 4 includes the descriptive statistics and the results of the hypothesis testing.

Chapter 4

Results

The purpose of this study was to determine the extent middle school administrators report engagement in leadership practices for science instruction (such as setting goals, supervising, coordinating resources, evaluating, establishing staff development, establishing school climate, and developing school/community relations). Another purpose of this study was to determine the extent gender, years of teaching experience, and years of administrative experience of middle school administrators influence reported engagement in leadership practices for science instruction. This chapter contains the descriptive statistics and the results of the data analysis.

Descriptive Statistics

Using the online website for the KSDE, United School Administrators, and individual school districts, 399 middle school administrators were identified and contacted to participate in this study via email. When the initial email was sent, 38 of the emails were returned as "undeliverable" due to the address no longer being active addresses for those individuals. In response, 38 new email addresses were identified, and two new addresses were added for individuals currently serving as middle school administrators.

Out of 401 middle school administrators, a 15% response rate was received (59 respondents); 46% of the respondents identified as female (n = 27), and 51% identified as male (n = 30); 3% of the respondents did not identify their gender (n = 2). The years of teaching experience for the respondents were collected, and the results are found in Table 3. No participants reported having had only 1-3 years of teaching experience.

Table 3

Participant Years of Teaching Experience

Years of Teaching Experience	*N*	% of Total
1-3 years	0	00.00
4-6 years	14	23.73
7-10 years	15	25.42
11-14 years	12	20.34
15 or more years	18	30.51

The years of administrative experience for the respondents was collected, and the results are found in Table 4. Two of the options identifying years of administrative experience (7- 10 years and 11- 14 years) received a smaller number of responses from participants. As a result, the two groups were combined to create a new group representing 7 to 14 years of administrative experience used during the statistical analysis of the survey data.

Table 4

Participant Years of Administrative Experience

Years of Administrative Experience	*N*	% of Total
1-3 years	17	28.82
4-6 years	16	27.12
7-10 years	7	11.86
11-14 years	7	11.86
15 or more years	12	20.34
Recoded Years of Administrative Experience		
1-3 years	17	28.81
4-6 years	16	27.12
7-14 years	14	23.73
15 or more years	12	20.34

Hypothesis Testing

The results of the hypothesis testing addressing the four research questions are discussed in this section. Each research question is followed by the data analysis, the hypotheses, and the results of the hypotheses testing.

RQ1. To what extent do middle school administrators perceive they are engaged in leadership practices for science instruction?

Eleven one-sample *t* tests were conducted to test H1-H11. The sample means for middle school administrators' perceptions of the frequency they engage in leadership behaviors were compared to a test value of 3. The one-sample *t* test was chosen for the hypothesis testing because it involves comparing one group mean with a known value, and the group mean calculated from a numerical variable. The level of significance was set at .05. When appropriate, the effect size, as indexed by Cohen's *d*, is reported.

H1. Middle school administrators perceive that they frequently or always ensure that school instructional goals for science are developed congruently with district policies.

The results of the one-sample *t* test for H1 indicated a statistically significant difference between the group mean and the test value, $t(58) = 5.025$, $p = .000$, Cohen's $d = 0.653$. The sample mean ($M = 3.66$, $SD = 1.01$) was significantly higher than the test value (3). H1 was supported. Middle school administrators perceive that they frequently or always ensure that school instructional goals for science are developed congruently with district policies. The effect size index indicated a medium effect.

H2. Middle school administrators perceive that they frequently or always work with teachers to coordinate the science instructional program between grades.

The results of the one-sample *t* test for H2 indicated there was not a statistically significant difference between the group mean and the test value, $t(58) = 0.883$, $p = .381$. The sample mean ($M = 3.10$, $SD = 0.89$) was not significantly different than the test value (3). H2 was not supported. Middle school administrators do not perceive that they frequently or always work with teachers to coordinate the science instructional program between grades.

H3. Middle school administrators perceive that they frequently or always participate in formal and/or informal discussions concerning science instruction as it impacts student achievement.

The results of the one-sample *t* test for H3 indicated a statistically significant difference between the group mean and the test value, $t(57) = 5.977$, $p = .000$, Cohen's *d* = 0.784. The sample mean (*M* = 3.62, *SD* = 0.79) was significantly higher than the test value (3). H3 was supported. Middle school administrators perceive that they frequently or always participate in formal and/or informal discussions concerning science instruction as it impacts student achievement. The effect size index indicated a medium effect.

H4. Middle school administrators perceive that they frequently or always systematically observe teachers' science instructional methods within the classroom.

The results of the one-sample *t* test for H4 indicated a statistically significant difference between the group mean and the test value, $t(58) = 8.833$, $p = .000$, Cohen's *d* =1.154. The sample mean (*M* = 3.90, *SD* = 0.78) was significantly higher than the test value (3). H4 was supported. Middle school administrators perceive that they frequently or always systematically observe teachers' science instructional methods within the classroom. The effect size index indicated a large effect.

H5. Middle school administrators perceive that they frequently or always ensure systematic procedures for monitoring student progress in science classes are utilized by staff.

The results of the one-sample *t* test for H5 indicated a statistically significant difference between the group mean and the test value, $t(56) = 2.751$, $p = .008$, Cohen's *d* = 0.366. The sample mean (*M* = 3.37, *SD* = 1.01) was significantly higher than the test value (3). H5 was supported. Middle school administrators perceive that they frequently or always ensure systematic procedures for monitoring student progress in science classes are utilized by staff. The effect size index indicated a small effect.

H6. Middle school administrators perceive that they frequently or always place emphasis on the meaning of test results for science program improvement.

The results of the one-sample *t* test for H6 indicated there was not a statistically significant difference between the group mean and the test value, $t(56) = 0.929$, $p = .357$. The sample mean ($M = 3.14$, $SD = 1.14$) was not significantly different than the test value (3). H6 was not supported. Middle school administrators do not perceive that they frequently or always place emphasis on the meaning of test results for science program improvement.

H7. Middle school administrators perceive that they frequently or always assist science teachers in securing available resources for program implementation.

The results of the one-sample *t* test for H7 indicated a statistically significant difference between the group mean and the test value, $t(57) = 5.246$, $p = .000$, Cohen's $d = 0.689$. The sample mean ($M = 3.71$, $SD = 1.03$) was significantly higher than the test value (3). H7 was supported. Middle school administrators perceive that they frequently or always assist science teachers in securing available resources for program implementation. The effect size index indicated a medium effect.

H8. Middle school administrators perceive that they frequently or always make regular visits to science classrooms.

The results of the one-sample *t* test for H8 indicated a statistically significant difference between the group mean and the test value, $t(58) = 10.325$, $p = .000$, Cohen's $d = 1.349$. The sample mean ($M = 4.12$, $SD = 0.83$) was significantly higher than the test value (3). H8 was supported. Middle school administrators perceive that they frequently or always make regular visits to science classrooms. The effect size index indicated a large effect.

H9. Middle school administrators perceive that they frequently or always, after observation, systematically help science teachers improve their effectiveness after observing.

The results of the one-sample *t* test for H9 indicated a statistically significant difference between the group mean and the test value, $t(57) = 5.738$, $p = .000$, Cohen's $d = 0.759$. The sample mean ($M = 3.66$, $SD = 0.87$) was significantly higher than the test value (3). H9 was supported. Middle school administrators perceive that they frequently or always, after observation, systematically help science teachers improve their effectiveness after observing. The effect size index indicated a medium effect.

H10. Middle school administrators perceive that they frequently or always identify science faculty in-service needs.

The results of the one-sample *t* test for H10 indicated there was not a statistically significant difference between the group mean and the test value, $t(56) = 0.566$, $p = .573$. The sample mean ($M = 3.09$, $SD = 1.17$) was not significantly different than the test value (3). H10 was not supported. Middle school administrators do not perceive that they frequently or always identify science faculty in-service needs.

H11. Middle school administrators perceive that they frequently or always evaluate science curricular programs.

The results of the one-sample *t* test for H11 indicated there was not a statistically significant difference between the group mean and the test value, $t(58) = -1.734$, $p = .088$. The sample mean ($M = 2.73$, $SD = 1.20$) was not significantly different than the test value (3). H11 was not supported. Middle school administrators do not perceive that they frequently or always evaluate science curricular programs.

RQ2. To what extent does gender influence middle school administrators' perceived engagement in leadership practices for science instruction?

Eleven independent-samples *t* tests were conducted to test H12-H22. Male and female middle school administrators' perceptions of the frequency they engage in leadership practices for science instruction were compared. An independent-samples *t* test was chosen for the hypothesis testing because the hypothesis tests involve the examination of the mean difference between two mutually exclusive independent groups (male and female middle school administrators), and the means are calculated using data for numerical variables. The level of significance was set at .05. When appropriate, an effect size, indexed by Cohen's *d*, is reported.

The results of the 11 independent-samples *t* tests indicated no statistically significant differences between the means for male and female middle school administrators. See Table 5 for the descriptive and test statistics for the *t* tests. H12-H22 were not supported. Gender does not influence middle school administrators' perceived engagement in leadership practices for science instruction.

H12. Middle school administrators' perceptions that they frequently or always participate in the development of school goals for science are affected by gender.

H13. Middle school administrators' perceptions that they frequently or always coordinate the science instructional program with teachers across grade levels for science are affected by gender.

H14. Middle school administrators' perceptions that they frequently or always hold formal/informal discussions of science instruction are affected by gender.

H15. Middle school administrators' perceptions that they frequently or always observe science teachers' instructional methods are affected by gender.

H16. Middle school administrators' perceptions that they frequently or always ensure systematic monitoring of student progress in science class by staff are affected by gender.

H17. Middle school administrators' perceptions that they frequently or always emphasize test results for science program involvement are affected by gender.

H18. Middle school administrators' perceptions that they frequently or always secure resources for science programs are affected by gender.

H19. Middle school administrators' perceptions that they frequently or always make regular science class visits are affected by gender.

H20. Middle school administrators' perceptions that they frequently or always help science teachers improve effectiveness after observing science classes are affected by gender.

H21. Middle school administrators' perceptions that they frequently or always identify in-service needs for science instruction are affected by gender.

H22. Middle school administrators' perceptions that they frequently or always evaluate science curricular program are affected by gender.

Table 5

Results of Independent-Samples t Tests for H12-H22

	Female			Male					
H	*M*	*SD*	*N*	*M*	*SD*	*N*	*t*	*df*	*p*
12	3.44	0.97	27	3.83	1.05	30	-1.442	55	.155
13	2.96	0.81	27	3.20	0.96	30	-1.002	55	.321
14	3.59	0.89	27	3.62	0.73	29	-0.130	54	.897
15	3.85	0.82	27	3.93	0.79	30	-0.384	55	.703
16	3.27	1.08	26	3.41	0.98	29	-0.520	53	.605
17	3.15	0.91	27	3.17	1.34	29	-0.079	54	.937
18	3.48	1.01	27	3.83	1.00	29	-1.284	54	.205
19	4.19	0.88	27	4.00	0.79	30	0.839	55	.405
20	3.81	0.96	27	3.45	0.74	29	1.608	54	.114
21	2.96	1.32	27	3.11	0.99	28	-0.460	53	.648
22	2.44	1.09	27	2.93	1.29	30	-1.542	55	.129

RQ3. To what extent does the number of years of teaching experience influence middle school administrators' perceived engagement in leadership practices for science instruction?

Eleven one-factor analyses of variance (ANOVAs) were conducted to test H23-H33. The categorical variable used to group the dependent variable, middle school administrators' perceptions of the frequency they engage in leadership practices for science instruction, was years of teaching experience (1-3 years, 4-6 years, 7-10 years, 11-14 years, 15 or more years). The results of the one-factor ANOVA can be used to test for differences in the means for a numerical variable among three or more groups. The level of significance was set at .05. When appropriate, an effect size, as indexed by eta-squared, is reported.

H23. Middle school administrators' perceptions that they frequently or always participate in the development of school goals for science are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = 0.627$, $df = 3, 55$, $p = .601$. See Table 6 for the means and standard deviations for this analysis. H23 was not supported. Middle school administrators' perceptions that they frequently or always participate in the development of school goals for science are not affected by their years of teaching experience.

Table 6

Descriptive Statistics for the Test of H23

Years	*M*	*SD*	*N*
1-3			
4-6	3.57	1.16	14
7-10	3.67	0.72	15
11-14	4.00	0.95	12
15 or more	3.50	1.15	18

Note. No participants reported 1-3 years of teaching experience.

H24. Middle school administrators' perceptions that they frequently or always coordinate the science instructional program with teachers across grade levels are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, F = 1.825, df = 3, 55, p = .153. See Table 7 for the means and standard deviations for this analysis. H24 was not supported. Middle school administrators' perceptions that they frequently or always coordinate the science instructional program with teachers across grade levels are not affected by their years of teaching experience.

Table 7

Descriptive Statistics for the Test of H24

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	2.64	0.63	14
7-10	3.20	0.78	15
11-14	3.17	1.03	12
15 or more	3.33	0.97	18

H25. Middle school administrators' perceptions that they frequently or always hold formal/informal discussions of science instruction are affected by their years of teaching experience.

The results of the analysis indicated a statistically significant difference between at least two of the means, F = 3.587, df = 3, 54, p = .019, η^2 = .166. See Table 8 for the means and standard deviations for this analysis. A follow up post hoc was conducted to determine which pairs of means were different. The Tukey's Honestly Significant Difference (HSD) post hoc was conducted at α = .05. One of the differences was statistically significant. The mean for middle school administrators with 15 or more years of teaching experience (*M* = 3.89) was higher than the mean for middle school administrators with 4-6 years of teaching experience mean (*M* = 3.07). H25 was supported. Middle school administrators' perceptions that they frequently or always hold formal/informal discussions of science instruction are affected by their years of teaching experience. The effect size index indicated a large effect.

Table 8

Descriptive Statistics for the Test of H25

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	3.07	0.83	14
7-10	3.79	0.70	14
11-14	3.67	0.65	12
15 or more	3.89	0.76	18

H26. Middle school administrators' perceptions that they frequently or always observe science teachers' instructional methods are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, F = 0.355, df = 3, 55, p = .786. See Table 9 for the means and standard deviations for this analysis. H26 was not supported. Middle school administrators' perceptions that they frequently or always observe science teachers' instructional methods are not affected by their years of teaching experience.

Table 9

Descriptive Statistics for the Test of H26

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	3.71	0.99	14
7-10	4.00	0.66	15
11-14	3.92	0.79	12
15 or more	3.94	0.73	18

H27. Middle school administrators' perceptions that they frequently or always ensure systematic monitoring of student progress in science class by staff are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, F = 0.916, df = 3, 53, p = .440. See Table 10 for the means and standard deviations for this analysis. H27 was not supported. Middle school administrators' perceptions that they frequently or always ensure systematic monitoring of student progress in science class by staff are not affected by their years of teaching experience.

Table 10

Descriptive Statistics for the Test of H27

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	3.08	1.19	13
7-10	3.53	0.72	15
11-14	3.17	1.19	12
15 or more	3.59	0.94	17

H28. Middle school administrators' perceptions that they frequently or always emphasize test results for science program involvement are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, F = 1.878, df = 3, 53, p = .144. See Table 11 for the means and standard deviations for this analysis. H28 was not supported. Middle school administrators' perceptions that they frequently or always emphasize test results for science program involvement are not affected by their years of teaching experience.

Table 11

Descriptive Statistics for the Test of H28

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	3.43	1.28	14
7-10	3.27	1.10	15
11-14	2.40	0.97	10
15 or more	3.22	1.06	18

H29. Middle school administrators' perceptions that they frequently or always secure resources for science programs are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = 0.820$, $df = 3, 54$, $p = .489$. See Table 12 for the means and standard deviations for this analysis. H29 was not supported. Middle school administrators' perceptions that they frequently or always secure resources for science programs are not affected by their years of teaching experience.

Table 12

Descriptive Statistics for the Test of H29

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	3.71	0.99	14
7-10	4.00	0.85	15
11-14	3.36	1.03	11
15 or more	3.67	1.19	18

H30. Middle school administrators' perceptions that they frequently or always make regular science class visits are affected by their years of teaching experience.

The results of the analysis indicated a statistically significant difference between at least two of the means, $F = 3.016$, $df = 3, 55$, $p = .038$, $\eta^2 = .141$. See Table 13 for the means and standard deviations for this analysis. A follow up post hoc was conducted to determine which pairs of means were different. The Tukey's Honestly Significant Difference (HSD) post hoc was conducted at $\alpha = .05$. One of the differences was statistically significant. The mean for middle school administrators with 15 or more years of teaching experience mean ($M = 4.33$) was higher than the mean for middle school administrators with 4-6 years of teaching experience mean ($M = 3.57$). H30 was supported. Middle school administrators' perceptions that they frequently or always make regular science class visits are affected by their years of teaching experience. The effect size index indicated a large effect.

Table 13

Descriptive Statistics for the Test of H30

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	3.57	0.94	14
7-10	4.20	0.78	15
11-14	4.33	0.65	12
15 or more	4.33	0.77	18

H31. Middle school administrators' perceptions that they frequently or always help science teachers improve effectiveness after observing science classes are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = 2.506$, $df = 3, 54$, $p = .069$. See Table 14 for the means and standard deviations for this analysis. H31 was not supported. Middle school administrators' perceptions that they frequently or always help science teachers improve effectiveness after observing science classes are not affected by their years of teaching experience.

Table 14

Descriptive Statistics for the Test of H31

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	3.21	0.89	14
7-10	4.07	0.70	15
11-14	3.64	1.03	11
15 or more	3.67	0.77	18

H32. Middle school administrators' perceptions that they frequently or always identify in-service needs for science instruction are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = 1.959$, $df = 3, 53$, $p = .131$. See Table 15 for the means and standard deviations for this analysis. H32 was not supported.

Middle school administrators' perceptions that they frequently or always identify in-service needs for science instruction are not affected by their years of teaching experience.

Table 15

Descriptive Statistics for the Test of H32

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	2.93	1.21	14
7-10	3.47	0.83	15
11-14	2.45	1.13	11
15 or more	3.29	1.31	17

H33. Middle school administrators' perceptions that they frequently or always evaluate science curricular program are affected by their years of teaching experience.

The results of the analysis indicated there was not a statistically significant difference between at least two of the means, $F = 0.983$, $df = 3, 55$, $p = .407$. See Table 16 for the means and standard deviations for this analysis. H33 was not supported. Middle school administrators' perceptions that they frequently or always evaluate science curricular program are not affected by their years of teaching experience.

Table 16

Descriptive Statistics for the Test of H33

Years	*M*	*SD*	*N*
1-3	--	--	--
4-6	2.29	1.07	14
7-10	2.93	1.03	15
11-14	2.67	1.44	12
15 or more	2.94	1.26	18

RQ4. To what extent does the number of years worked in administrative positions influence middle school administrators' perceived engagement in leadership practices for science instruction?

Eleven one-factor ANOVAs were conducted to test H34-H44. The categorical variable used to group the dependent variable, middle school administrators' perceptions of the frequency they engage in leadership practices for science instruction, was years of administrative experience (1-3 years, 4-6 years, 7-14 years, 15 or more years). The results of the one-factor ANOVA can be used to test for differences in the means for a numerical variable among three or more groups. The level of significance was set at .05. When appropriate, an effect size, as indexed by eta-squared, is reported.

The results of the 11 ANOVAs indicated no statistically significant differences among the means. See Table 17 for the test statistics for the analyses. A table containing the means and standard deviations for the analysis follows each hypothesis listed after Table 17.

Table 17

Test Statistics for the ANOVAs Conducted to Test H34-H44

H	*F*	df_1, df_2	*p*
34	1.551	3, 55	.212
35	1.302	3, 55	.283
36	0.920	3, 54	.437
37	1.057	3, 55	.375
38	1.993	3, 53	.126
39	0.954	3, 53	.421
40	1.833	3, 54	.152
41	0.401	3, 55	.753
42	1.621	3, 54	.195
43	2.048	3, 53	.118
44	0.389	3, 55	.761

H34. Middle school administrators' perceptions that they frequently or always participate in the development of school goals for science are affected by their years of worked in administrative positions.

Table 18

Descriptive Statistics for the Test of H34

Years	*M*	*SD*	*N*
1-3	3.53	1.18	17
4-6	3.31	1.01	16
7-14	3.93	0.83	14
15 or more	4.00	0.85	12

H35. Middle school administrators' perceptions that they frequently or always coordinate the science instructional program with teachers across grade levels are affected by their years of worked in administrative positions.

Table 19

Descriptive Statistics for the Test of H35

Years	*M*	*SD*	*N*
1-3	2.88	0.86	17
4-6	2.94	0.85	16
7-14	3.43	0.85	14
15 or more	3.25	0.97	12

H36. Middle school administrators' perceptions that they frequently or always hold formal/informal discussions of science instruction are affected by their years of worked in administrative positions.

Table 20

Descriptive Statistics for the Test of H36

Years	*M*	*SD*	*N*
1-3	3.47	0.94	17
4-6	3.50	0.63	16
7-14	3.69	0.86	13
15 or more	3.92	0.67	12

H37. Middle school administrators' perceptions that they frequently or always observe science teachers' instructional methods are affected by their years of worked in administrative positions.

Table 21

Descriptive Statistics for the Test of H37

Years	*M*	*SD*	*N*
1-3	3.76	0.66	17
4-6	3.81	0.91	16
7-14	3.86	0.66	14
15 or more	4.25	0.87	12

H38. Middle school administrators' perceptions that they frequently or always ensure systematic monitoring of student progress in science class by staff are affected by their years worked in administrative positions.

Table 22

Descriptive Statistics for the Test of H38

Years	*M*	*SD*	*N*
1-3	3.25	0.86	16
4-6	2.93	0.88	15
7-14	3.71	1.07	14
15 or more	3.67	1.16	12

H39. Middle school administrators' perceptions that they frequently or always emphasize test results for science program involvement are affected by their years of worked in administrative positions.

Table 23

Descriptive Statistics for the Test of H39

Years	*M*	*SD*	*N*
1-3	2.94	1.12	16
4-6	2.93	1.16	15
7-14	3.21	1.12	14
15 or more	3.58	1.17	12

H40. Middle school administrators' perceptions that they frequently or always secure resources for science programs are affected by their years of worked in administrative positions.

Table 24

Descriptive Statistics for the Test of H40

Years	*M*	*SD*	*N*
1-3	3.44	1.21	16
4-6	3.44	0.96	16
7-14	3.93	0.92	14
15 or more	4.17	0.84	12

H41. Middle school administrators' perceptions that they frequently or always make regular science class visits are affected by their years of worked in administrative positions.

Table 25

Descriptive Statistics for the Test of H41

Years	*M*	*SD*	*N*
1-3	4.12	0.86	17
4-6	3.94	0.77	16
7-14	4.21	0.98	14
15 or more	4.25	0.75	12

H42. Middle school administrators' perceptions that they frequently or always help science teachers improve effectiveness after observing science classes are affected by their years of worked in administrative positions.

Table 26

Descriptive Statistics for the Test of H42

Years	*M*	*SD*	*N*
1-3	3.44	0.81	16
4-6	3.44	0.81	16
7-14	4.00	0.96	14
15 or more	3.83	0.84	12

H43. Middle school administrators' perceptions that they frequently or always identify in-service needs for science instruction are affected by their years of worked in administrative positions.

Table 27

Descriptive Statistics for the Test of H43

Years	*M*	*SD*	*N*
1-3	2.67	1.05	15
4-6	2.88	1.03	16
7-14	3.29	1.27	14
15 or more	3.67	1.23	12

H44. Middle school administrators' perceptions that they frequently or always evaluate science curricular programs are affected by their years of worked in administrative positions.

Table 28

Descriptive Statistics for the Test of H44

Years	*M*	*SD*	*N*
1-3	2.53	1.23	17
4-6	2.69	1.14	16
7-14	3.00	1.30	14
15 or more	2.75	1.22	12

Summary

The detailed descriptive data analysis results for each hypothesis assessed in this research study were presented in this chapter. The data analysis revealed that nine hypotheses were found to have significant data outcomes, and four hypotheses measured largely significant results. Chapter 5 includes a study summary, findings related to the literature, and conclusions.

Chapter 5

Interpretation and Recommendations

In this study, Kansas middle school administrators reported their perceived levels of engagement in specific instructional leadership behaviors with teachers of science and administrators' behaviors were compared based on their gender, teaching experience, and administrative experience. Despite research on this subject being limited and a small number of participant responses to the research survey, the data produced from this study administrators perceive that they highly engage in numerous instructional leadership behaviors. This chapter contains a summary of the study, findings related to the literature, and the conclusion.

Study Summary

Four research questions were developed to explore the frequency of practice of eleven specific leadership behaviors identified by Heck et al.'s (1990) Instructional Activities Questionnaire in general, as well as based on their personal and professional characteristics, by Kansas middle school administrators supporting science teachers and classrooms teaching the NGSS curriculum. Although only a 15% response rate was received, the data reflected that 9 of the 44-hypothesis predicted were supported with medium to large effect sizes. This section includes a review of the problem, the purpose statement and research questions, the methodology, and the major findings.

Overview of the problem. Science education in K-12 schools in the U.S. has not been given the attention it deserves (Kuenzi, 2008; Shaw, 1994). Furthermore, instructional leadership behavior in K-12 science education in the U.S. has received even less interest (Lowenhaupt et al., 2019). Despite the lack of national interest, STEM education and careers have expanded rapidly worldwide over the past 25 years, so much that the U.S. no longer ranks highest in science and technology fields based on the proportion of STEM degrees awarded (Kuenzi, 2008). The development and adoption of the NGSS curriculum in the U.S. transformed the teaching of K- 12 science concepts, theories, and practices into a content area needing dual leadership styles for teacher instruction, student performance, and school achievement that most middle school administrators do not possess (Lowenhaupt et al., 2019).

Purpose statement and research questions. The first purpose of this study was to determine the extent middle school administrators report engagement in leadership practices for science instruction (such as setting goals, supervising, coordinating resources, evaluating, establishing staff development, establishing school climate, and developing school/community relations). The second purpose of this study was to determine the extent Kansas middle school administrators' gender, number of years of teaching experience, and number of years worked in administrative positions influence their reported engagement in leadership practices for science instruction. Four research questions were posed to address the study's purposes, and 44 hypotheses were tested.

Review of the methodology. A quantitative descriptive design involving a survey method was used in this study. The dependent variables in the study were Kansas middle school administrators' perceptions of their level of engagement in instructional leadership behaviors and science practices; the participant's gender, years of teaching experience, and years of administrative experience were independent variables. The Instructional Activity Measurement Subscale developed from Larsen's (1985) research on leadership behaviors and modified by Heck et al.'s (1990) research on instructional leadership behaviors was used for this research study. The actual items in the instructional organization subscale were not modified from Heck's version. In testing the 11 hypotheses associated with RQ1, a one-sample *t* test was conducted; for the 11 hypotheses related to RQ2, independent-sample *t* tests were conducted. A one-factor ANOVA was used to test the 11 hypotheses associated with RQ3 and the 11 hypotheses related to RQ4.

Major findings. The results of the hypothesis testing show that middle school administrators perceive that they frequently or always:

- ensure that school instructional goals for science are developed congruently with district policies,
- participate in formal and/or informal discussions concerning science instruction as it impacts student achievement,
- systematically observe teachers' science instructional methods within the classroom,
- ensure systematic procedures for monitoring student progress in science classes are utilized by staff,
- assist science teachers in securing available resources for program implementation,
- make regular visits to science classrooms, and
- after observation, systematically help science teachers improve their effectiveness after observing.

Middle school administrators did not perceive that they frequently or always:

- work with teachers to coordinate the science instructional program across grades,

- place emphasis on the meaning of test results for science program improvement,
- identify science faculty in-service needs, and
- evaluate science curricular programs.

Gender was not the basis for any significant differences in the perceived instructional leadership behaviors in science. The following perceived leadership behaviors of middle school administrators were affected by their years of teaching experience:

- hold formal/informal discussions of science instruction are affected by their years of teaching experience, and
- make regular science class visits are affected by their years of teaching experience.

The following perceived leadership behaviors of middle school administrators were not affected by their years of teaching experience:

- participate in the development of school goals for science are not affected by their years of teaching experience,
- coordinate the science instructional program with teachers across grade levels are not affected by their years of teaching experience,
- observe science teachers' instructional methods are not affected by their years of teaching experience,
- ensure systematic monitoring of student progress in science class by staff is not affected by their years of teaching experience,
- emphasize test results for science program involvement are not affected by their years of teaching experience,

- secure resources for science programs are not affected by their years of teaching experience,
- help science teachers improve effectiveness after observing science classes are not affected by their years of teaching experience,
- identify in-service needs for science instruction are not affected by their years of teaching experience, and
- evaluate science curricular programs are not affected by their years of teaching experience.

Finally, the years of administrative experience did not affect the perceived engagement of Kansas middle school administrators in instructional leadership behaviors in science.

Findings Related to the Literature

The current findings support previous findings. Nine of the 44 hypotheses in the study support past research study findings. Seven behaviors ranked high in the frequency of engagement from administrators overall, and two behaviors ranked high in the frequency of engagement based on administrators' years of teaching experience. Kansas middle school administrators reported that they frequently ensure that school instructional goals for science are developed congruently with district policies, systematically observe teachers' science instructional methods within the classroom, and systematically help science teachers improve their effectiveness in observing. Heck et al.'s (1990) study provided evidence that specific leadership behaviors directed toward instructional organization highly impact student achievement (i.e., developing class and school goals, observing/ supervising instruction, and delivering immediate feedback to teachers). As identified in this study, these same leadership behaviors were perceived to be practiced by middle school administrators overseeing the science curriculum and instruction.

The findings in the current study are in contrast with Lowenhaupt and McNeill's (2019) and Winn's (2016) findings. Lowenhaupt and McNeil (2019) found that Massachusetts K-8 principals responsible for science curriculum leadership provided minimal science supervision, rarely conducted formal observations of science classrooms, and employed teacher evaluation systems non-reflective of the characteristics and requirements of the modern curriculum. The current study's findings revealed that Kansas middle school administrators perceive that they frequently or always make regular visits to science classrooms. Winn (2016) determined that elementary principals across many states, including Kansas, did not engage in frequent science leadership practices even as their schools implemented the NGSS.

The results of the current study indicate that gender did not influence Kansas middle school administrators' perceived engagement in leadership practices for NGSS science instruction. Winn (2016) identified that gender, race, and earning a science or STEM degree were not significant predictors of instructional leadership practices for science. Furthermore, Winn (2016) concluded that more years of classroom teaching experience and more years of administrative experience correlate positively with instructional leadership behaviors. Principals who previously taught science more recently had more frequent occurrences of instructional leadership practices in science classrooms (Winn, 2016). In contrast to Winn, the current study findings revealed that the number of years of teaching experience influences middle school administrators' perceived engagement in leadership practices for science instruction, specifically the frequency of holding formal/informal discussions of science instruction and making regular science class visits. The results of this study indicate that years of administrative experience did not influence Kansas middle school administrators' perceived engagement in leadership practices for NGSS instruction.

Conclusions

Kansas middle school administrators perceive themselves to engage in several specific instructional leadership behaviors when overseeing science instruction. By identifying instructional leadership behaviors present and lacking from school leadership supervising NGSS instruction, and the factors influencing their delivery to science teachers, action planning for the continued development of instructional leaders and improvement of science education can become target areas for both school and district continuous improvement plans. This section includes the implications for action, recommendations for future research, and concluding remarks.

Implications for action. Based on the findings from this study, there are some suggestions to be considered for future action. For the states that have implemented the NGSS curriculum, school districts would benefit from taking a critical look at the effectiveness of the new educational program for improving teacher instruction, student performance, and district achievement in science. This recommendation is based on the finding that Middle School administrators did not perceive that they frequently or always place emphasis on the meaning of test results for science program improvement.

Attention to professional support and resources for teachers of science curriculum is critically important for student and school performance. STEM experts should be invited into schools through community and corporate partnerships with school districts to support educators who do not possess content background knowledge. Mutual benefits include creative lesson planning, rigorous teaching and instruction, higher quality educational experiences (i.e., virtual field trips, guest speakers, hands-on simulations, etc.), greater college and career interests, and formal/informal professional development. To aid principals in learning NGSS science practices and core features, school principals need professional development opportunities to observe and compare teaching practices across subjects, such as mathematics and language arts, to recognize and understand subject-specific teaching and learning qualities. Furthermore, the professional development engagement would enable comparisons to subjects in which principals have stronger backgrounds.

Professional development workshops and conferences related to science instruction are typically conducted for teachers, support staff, and aides in classrooms. Based on the finding that middle school administrators did not perceive that they frequently or always identified science faculty in-service needs, the same type of professional education and training should also be provided for school administrators to assist them in building and strengthening leadership practices for identifying science faculty in-service needs. Principals, curriculum leaders, and supervising administrators would benefit from continuous learning, practice, and coaching on leadership behaviors, content, and pedagogical knowledge related to science instruction. Although leadership behaviors are transferrable between subject areas, the availability, frequency, and commitment of those professional performing behaviors must be adapted for each subject. Professional development training for administrators can support principals responsible for instructional leadership support to teachers for learning, practice, and expansion of instructional qualities, skills, and behaviors applicable and modernized for present-day science education.

Recommendations for future research. The results of this study added to the large pool of literature on instructional leadership. Since research on K-12 science instructional leadership is limited, it is expected that this study could generate further interest in science education research in the U.S. Several general recommendations for future research include replicating this study using a different state, different study population, such as elementary school and high school administrators, or using a different study instrument. An extension of this could be to survey Kansas science teachers' perceptions of building administrators' engagement in instructional leadership practices for NGSS science instruction to determine the differences in perceived engagement between both groups.

This study was conducted during the COVID-19 pandemic when schools returned to in-person instruction. The operation of schools within the extreme conditions of this world health crisis created a hectic position for building administrators. Resurveying Kansas middle school administrators during a more traditional or typical school year could produce different findings. The response rate for study participants would likely increase demographic representation and survey results for each hypothesis tested.

Examining instructional leadership behaviors in science using a qualitative study method could be beneficial. In this type of study, the research could focus more closely on building administrators' perceptions of (or experiences with) specific leadership behaviors, demographics, and influential factors. Insight into the strengths and weaknesses of administrators' leadership behaviors and the effectiveness of behaviors on teacher and student performance might be found.

Concluding remarks. If science instruction and education in the United States were researched more intensely, science might be prioritized by the U.S. Department of Education as highly as mathematics and reading. Middle school principals are providing instructional leadership for teachers of science utilizing the NGSS curriculum, but more is needed. The levels of instructional leadership delivered by principals to instructors teaching NGSS vary because principals, too, require leadership training for supervising the NGSS curriculum. The curriculum is foreign to professionals with no background or experience in science. District leadership should secure external resources for the professional development of school administrators in science. Administrators should attend more training, workshops, seminars, and conferences from science professionals such as the NSTA to develop greater education on the full NGSS curriculum and how to perform instructional behaviors specifically for supervising and coaching science instruction. This type of training, paired with continued professional development in administrative leadership, will expand student, teacher, and school engagement levels, personal abilities, and performance achievement.

References

Andrews, R., & Soder, R. (1987). Principal instructional leadership and student achievement. *Educational Leadership, 44*(6), 9-11. Retrieved from https://www.ascd.org/el/articles/principal-leadershi-and-student-achievement

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37,* 122-147. doi:10.1037/0003-066X.37.2.122

Bossert, S., Dwyer, D., Rowan, B., and Lee, G. (1982). The instructional management role of the principal. *Education Administration Quarterly, 18*(3), 34-64. https://doi.org/10.1177%2F0013161X82018003004

Burch, P., & Spillane, J. P. (2003). Elementary school leadership strategies and subject matter: Reforming mathematics and literacy instruction. *The Elementary School Journal, 103*(5), 519-535. http://dx.doi.org/10.1086/499738

Bybee, R. W. (2014). NGSS and the next generation of science teachers. *Journal of Science Teacher Education, 25*(2), 211-221. doi:10.1007/s10972-014-9381-4

Chance, P. L., & Anderson, R. B. (2003*). The principal's role in standards-based reform: Linking accountability to instructional improvement*. Paper presented at the American Educational Research Association Annual Meeting, Chicago, IL.

Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Upper Saddle River, NJ: Pearson Education.

Desimone, L., & Pak, K. (2017). Instructional coaching as high-quality professional development. *Theory Into Practice, 53,* 6-12. doi:10.1080/00405841.2016.1241947

Ersozlu, A. (2016). School principals' reflective leadership skills through the eyes of science and mathematics teachers. *International Journal of Environmental & Science Education*, *11(*5), 801-808. doi:10.12973/ijese.2016.349a

Hallinger, P. (2005). Instructional leadership and the school principal: A passing fancy that refuses to fade away. *Leadership and Policy in Schools*, *4*, 221-239. https://doi.org/10.1080/15700760500244793

Hallinger, P., Wang, W., Chen, C., & Li, D. (2015). *Assessing instructional leadership with the Principal Instructional Management Rating Scale*. New York, NY: Springer.

Heck, R. H., Larsen, T. J., & Marcoulides, G. A. (1990). Instructional leadership and school achievement: Validation of a causal model. *Educational Administration Quarterly, 26*, 94-125. doi:10.1177/0013161X90026002002

Institute of Education Sciences & National Center for Educational Statistics. (2011). *Schools & Staffing Survey (SASS) 2011-2012*. Retrieved from https://nces.ed.gov/timss/results19/index.asp#/science/intlcompare

Institute of Education Sciences & National Center for Educational Statistics. (2019). *TIMSS 2019 U. S. Highlights Web Report* (NCES 2021-021). Retrieved from https://nces.ed.gov/timss/results19/index.asp

Kansas State Department of Education. (2007). *Kansas science education standards.* Retrieved from https://community.ksde.org/LinkClick.aspx?fileticket=49KllvxS4nc%3D&tabid=4697&mid=11426

Kansas State Department of Education. (2009). *Kansas science standards executive summary*. Retrieved from https://community.ksde.org/LinkClick.aspx?fileticket=wZ4EnOxG1vY%3d&tabid=5785&mid=14106

Kuenzi, J. J. (2008). *Science, technology, engineering, and mathematics (STEM) education: Background, federal policy, and legislative action*. Retrieved from https://www.fas.org/sgp/crs/misc/RL33434.pdf

Larsen, T. (1985). *Identification of instructional leadership behaviors and the impact of their implementation on academic achievement* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses database. (UMI No. 8508956)

Leithwood, K. (1994). Leadership for school restructuring. *Educational Administration Quarterly, 30*(4), 498-518. https://doi.org/10.1177%2F0013161X94030004006

Lochmiller, C. R. (2016). Examining administrators' instructional feedback to high school math and science teachers. *Educational Administration Quarterly, 52*(1), 75-109. doi:10.1177/0013161x15616660

Lochmiller, C. R., Huggins, K. S., & Acker-Hocevar, M. A. (2012). Preparing leaders for math and science: Three alternatives to traditional preparation. *Planning and Changing, 43*(1-2), 198-220. Retrieved from ERIC database. (EJ977555)

Lochmiller, C., & Acker-Hocevar, M. (2016). Making sense of principal leadership in content areas: The case of secondary math and science instruction. *Leadership and Policy in Schools, 15*(3), 273-296. http://dx.doi.org/10.1080/15700763.2015.1073329

Lowenhaupt, R., & McNeill, K. (2019). Subject-specific instructional leadership in K-8 schools: The supervision of science in an era of reform. *Leadership and Policy in Schools, 18*(3), 460-484. https://doi.org/10.1080/15700763.2018.1453937

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

McNeill, K. L., Lowenhaupt, R., & Katsh-Singer, R. (2018). Instructional leadership and the implementation of the NGSS: Principals' understandings of science practices. *Science Education, 102*(3), 452-473. https://doi.org/10.1002/sce.21336

Merriam- Webster Dictionary Online. (2022). *Middle school*. Merriam Webster, Inc. Retrieved from https://www.merriam-webster.com/dictionary/middle%20school

National Center for Education Statistics. (2011). *Trends in international mathematics and science study (TIMSS): Science achievement of fourth- and eighth graders in 2011*. Retrieved from https://nces.ed.gov/timss/results11_science11.asp

National Center for Education Statistics. (2019). *Trends in international mathematics and science study (TIMSS): Science achievement of fourth- and eighth graders in 2019*. Retrieved from https://timss2019.org/reports/achievement/#science-8

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core idea*. Washington, DC: National Academies Press.

Next Generation Science Standards. (2013a). *NGSS executive summary*. Retrieved from https://www.nextgenscience.org/sites/default/files/Final%20Release%20NGSS%20Front%20Matter%20-%206.17.13%20Update_0.pdf

Next Generation Science Standards. (2013b). *Understanding the standards*. Retrieved from https://www.nextgenscience.org/understanding-standards/understanding-standards

Next Generation Science Standards. (2016). *NGSS facts sheet*. Retrieved from https://www.nextgenscience.org/resources/ngss-fact-sheet

Next Generation Science Standards. (2017). *NGSS district implementation indicators*. Retrieved from https://www.nextgenscience.org/sites/default/files/NGSS%20District%20Implementation%20Indicators%20-%20FINAL_0.pdf

Next Generation Science Standards. (2021a). *NGSS lead state partners*. Retrieved from https://www.nextgenscience.org/lead-state-partners

Next Generation Science Standards. (2021b). *NGSS developing the standards. Retrieved from* https://www.nextgenscience.org/developing-standards/developing-standards

Painter, B., & Valentine, J. (1996). *Instructional practices inventory*. Columbia, MO: Missouri Center for School Improvement, University of Missouri.

Pitner, N., & Hocevar, D. (1987). An empirical comparison of two-factor versus multifactor theories of principal leadership: Implications for the evaluation of school principals. *Journal of Personnel Evaluation in Education, 1*(1), 93-109. https://doi.org/10.1007/BF00143281

Pratt, H. (2013). *The NSTA reader's guide to a framework for K-12 science education.* Arlington, VA: NSTA Press.

Prince, S. (2021). *Principals' and teachers' perceptions of content-specific instructional feedback* (Doctoral dissertation) Retrieved from ProQuest Dissertations and Theses database. (ProQuest No. 28962394)

Pruitt, S. L. (2014). The next generation science standards: The features and challenges. *Journal of Science Teacher Education, 25*(2), 145-156. https://doi.org/10.1007/s10972-014-9385-0

Quebec Fuentes, S., & Jimerson, J. B. (2020). Role enactment and types of feedback: The influence of leadership content knowledge on instructional leadership efforts. *Journal of Educational Supervision*, *3*(2), 6-31. https://doi.org/10.31045/jes.3.2.2

Quinn, D. (2002). The impact of principal leadership behaviors on instructional practice and student engagement. *Journal of Educational Administration*, *40*(4/5), 447-467. https://doi.org/10.1108/09578230210440294

Robinson, V. M. J., Lloyd, C. A., & Rowe, K. J. (2008). The impact of leadership on student outcomes: An analysis of the differential effects of leadership types. *Educational Administration Quarterly, 44*(5), 635- 674. doi:10.1177/0013161x08321509

Sackett, P. R., & Larson, J. R. (1990). Research strategies and tactics in industrial and organizational psychology. *Handbook of industrial and organization psychology*, (pp. 419-489). Palo Alto, CA: Consulting Psychologist Press.

Science education in the 21st century: Why K–12 science standards matter—and why the time is right to develop next-generation science standards. (2012). Retrieved from https://www.nextgenscience.org/sites/default/files/Why%20K12%20Standards%20Matter%20-%20FINAL.pdf

Shaw, E. L., Doan, R. L., & Hale, R. P. (1994). *The impact of administrators' interest in science teaching upon teachers' perceptions of the importance of teaching science*. Retrieved from ERIC database. (ED391780)

Spillane, J. P., Diamond, J. B., Waler, L. J., Halverson, R., & Jita, L. (2001). Urban school leadership for elementary science instruction: Identifying and activating resources in an undervalued school subject. *Journal of Research in Science Teaching*, *38*, 918-940. http://dx.doi.org/10.1002/tea.1039

Stein, M., & Nelson, B. (2003). Leadership content knowledge. *Educational Evaluation and Policy Analysis, 25*(4), 423-448. doi:10.3102/01623737025004423

Williams, R. (2019). *Exploring the perceptions of secondary assistant principals toward their development as instructional leaders* (Doctoral dissertation, University of North Florida). Retrieved from https://diditalcommons.unf.edu/cgi/viewcontent.cgi?article=1926&content=etd

Winn, K. (2016). *Instruction leadership in elementary science: How are school leaders positioned to lead in a next generation science standards era* (Doctoral dissertation)*?* Retrieved from ProQuest Dissertations and Theses database. (ProQuest No. 10143199)

Yehuda P., Yael, K., & Yehudit, J. D. (2011). School principals' influence on science teachers' technology implementation: A retrospective analysis. *International Journal of Leadership in Education, 14*(2), 229- 245. doi:10.1080/13603124.2010524249

Appendices

Appendix A: Permission to Use Survey for Research Study

From: Ronald Heck <rheck@hawaii.edu>
Date: October 26, 2020 at 8:04:41 PM CDT
To: Susan Rogers <Susan.Rogers@bakeru.edu>
Subject: [EXTERNAL]Re: Instructional Activity Measurement Subscale

Hi Susan -- fine by me if your student wishes to use the survey -- You can also alter it in any way that might
serve your research.
Best regards,
ron

On Mon, Oct 26, 2020, at 2:16 PM Susan Rogers <Susan.Rogers@bakeru.edu> wrote:

Dear Dr. Heck:

I have a doctoral candidate (Janel Paschall) who is interested in using your survey "**Instructional Activity Measurement Subscale**" in her research. Will you grant permission for her to use your survey?

Thank you for your consideration.

Susan K. Rogers, Ph.D.
Baker University
Associate Professor
Graduate School of Education
P.O. Box 65
Baldwin City, Kansas 66006
Mobile: 785-230-2801

From: Iris Riggs <IRiggs@csusb.edu>
Sent: Monday, October 26, 2020, 7:37 PM
To: Susan Rogers <Susan.Rogers@bakeru.edu>
Subject: [EXTERNAL]Re: Science Teaching Efficacy and Belief Instrument Subscale

Hello,

It's fine to use the instrument and make changes.

Best wishes!
Iris

Iris Riggs, Ph.D.
Professor Emeritus
Department of Teacher Education and Foundations
California State University, San Bernardino

5500 University Parkway
San Bernardino, CA 92407

From: Susan Rogers <Susan.Rogers@bakeru.edu>
Date: Monday, October 26, 2020 at 5:24 PM
To: Iris Riggs <IRiggs@csusb.edu>
Subject: Science Teaching Efficacy and Belief Instrument Subscale

Dear Dr. Riggs:

I have a doctoral candidate (Janel Paschall) who would like to use your survey “Science Teaching Efficacy and Belief Instrument Subscale” in her study. She would like to change the statement “please think about how you would answer if you were currently teaching elementary science” to “please think about how you would answer if you were currently teaching middle school science.”

Thank you for your consideration.

Susan K. Rogers, Ph.D.
Baker University
Associate Professor
Graduate School of Education
P.O. Box 65
Baldwin City, Kansas 66006
Mobile: 785-230-2801

Appendix B: Instructional Activity Measurement Subscale Survey

Instructional Activity Measurement Subscale

During the 2021- 2022 school year, select how often you engage in the following leadership practices in SCIENCE.

Please respond to the following statements using a scale of 1 - 5.
1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Frequently, and 5 = Always.
In/ for SCIENCE, . . . *

	Never (1)	Rarely (2)	Sometimes (3)	Frequently (4)	Always (5)
I ensure that school instructional goals for science are developed congruently with district policies.	[ ]	[ ]	[ ]	[ ]	[ ]
I work with teachers to coordinate the science instructional program between grades.	[ ]	[ ]	[ ]	[ ]	[ ]
I participate in formal and/or informal discussions concerning science instruction as it impacts student achievement.	[ ]	[ ]	[ ]	[ ]	[ ]
I systematically observe teachers' science instructional methods within the classroom.	[ ]	[ ]	[ ]	[ ]	[ ]
I ensure systemic procedures for monitoring student progress in science classes are utilized by staff.	[ ]	[ ]	[ ]	[ ]	[ ]
I place emphasis on the meaning of test results for science program involvement.	[ ]	[ ]	[ ]	[ ]	[ ]

I assist science teachers in securing available resources for program implementation.	[ ]	[ ]	[ ]	[ ]	[ ]
I make regular visits to science classrooms.	[ ]	[ ]	[ ]	[ ]	[ ]
After observation, I systemically help science teachers improve their effectiveness.	[ ]	[ ]	[ ]	[ ]	[ ]
I identify science faculty in-service needs.	[ ]	[ ]	[ ]	[ ]	[ ]
I evaluate science curricular programs.	[ ]	[ ]	[ ]	[ ]	[ ]

Demographic Items

Gender

- ( ) Female
- ( ) Male

Number of years of TEACHING experience

- ( ) 1 - 3 years
- ( ) 4 - 6 years
- ( ) 7 - 10 years
- ( ) 11 - 14 years
- ( ) 15 or more years

Number of years worked in ADMINISTRATIVE positions

- ( ) 1 - 3 years
- ( ) 4 - 6 years
- ( ) 7 - 10 years
- ( ) 11 -14 years
- ( ) 15 or more years

Appendix C: IRB Approval Letter

Baker University Institutional Review Board

January 7th, 2022

Dear Janel Paschall and Susan Rogers,

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 Poell, MLS
Chair, Baker University IRB

Baker University IRB Committee
Sara Crump, PhD
Nick Harris, MS
Christa Hughes, PhD
Susan Rogers, PhD

Appendix D: Survey Solicitation Letter

Dear Middle School Building Principal,

My name is Janel Paschall, and I am currently a doctoral student at Baker University. The title of my study is Middle School administrators' Perceptions of Their Engagement in Leadership Practices for Next Generation Science Standards Science Instruction. The purpose of my study is to determine the extent middle school administrators report engagement in leadership practices for science instruction. An additional purpose of the study is to determine the extent gender, teaching experience, and administrative experience influence reported engagement in leadership practices for science. Participation in this study is voluntary. There are no risks associated with your participation, and should you decide not to submit the survey, there will be no repercussions.

Completion of the survey will indicate your consent to participate in the study. The survey is entirely confidential. Your name and email address will not be collected, and all responses will be reported in summary form. Responses will remain anonymous, and data will not be associated with any individual respondent. The survey consists of 11 items and four demographic questions relating to gender, years of teaching experience, and years of administrative experience. Please use the link below to access and complete the survey by March 15, 2022.

Survey Link: https://forms.gle/6do8QguWT8Pzsed56

Thank you in advance for your time and participation in this study. If you have questions about this survey, the study, or your rights as a participant, please contact me by email at janelnpaschall@stu.bakeru.edu, 913-265-9210 or my major advisor, Dr. Susan Rogers, at srogers@bakeru.edu.

Sincerely,

Janel Paschall
Baker University Doctoral Candidate

Appendix E: Survey Solicitation Letter Reminders

Dear Middle School Building Principal,

You were contacted three weeks ago about participating in a study examining *Middle School administrators' Perceptions of Their Engagement in Leadership Practices for Next Generation Science Standards Science Instruction.* If you already completed the survey, thank you and disregard this email. If you have not completed the survey, I would greatly appreciate your voluntary participation in this study; you may choose to withdraw at any time without penalty or repercussion.

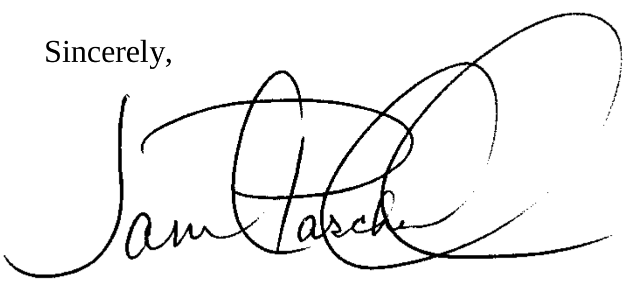
The purpose of my study is to determine the extent middle school administrators report engagement in leadership practices for science instruction. An additional purpose of the study is to determine the extent gender, teaching experience, and administrative experience influences reported engagement in leadership practices for science. Participation in this study is voluntary. There are no risks associated with your participation, and should you decide not to submit the survey, there will be no repercussions.

Completion of the survey will indicate your consent to participate in the study. The survey is entirely confidential. Your name and email address will not be collected, and all responses will be reported in summary form. Responses will remain anonymous, and data will not be associated with any individual respondent. The survey consists of 11 items and four demographic questions relating gender, years of teaching experience, and years of administrative experience. Please use the link below to access and complete the survey by April 1, 2022.

Survey Link: https://forms.gle/6do8QguWT8Pzsed56

Thank you in advance for your time and participation in this study. If you have questions about this survey, the study, or your rights as a participant, please contact me by email at janelnpaschall@stu.bakeru.edu, 913-265-9210 or my major advisor, Dr. Susan Rogers, at srogers@bakeru.edu.

Sincerely,



Janel Paschall
Baker University Doctoral Candidate

Dear Middle School Building Principal,

You were contacted previously about participating in a study examining *Middle School Administrators' Perceptions of Their Engagement in Leadership Practices for Next Generation Science Standards Science Instruction* due by April 1, 2022. Due to the spring break schedule, I have chosen to extend the deadline for participating to **April 15, 2022**. If you already completed the survey, thank you and disregard this email. If you have not completed the survey, I would greatly appreciate your voluntary participation in this study; you may choose to withdraw at any time without penalty or repercussion.

The purpose of my study is to determine the extent middle school administrators report engagement in leadership practices for science instruction. An additional purpose of the study is to determine the extent gender, teaching experience, and administrative experience influence reported engagement in leadership practices for science. Participation in this study is voluntary. There are no risks associated with your participation, and should you decide not to submit the survey, there will be no repercussions.

Completion of the survey will indicate your consent to participate in the study. The survey is entirely confidential. Your name and email address will not be collected, and all responses will be reported in summary form. Responses will remain anonymous, and data will not be associated with any individual respondent. The survey consists of 11 items and four demographic questions relating to gender, year of teaching experience, and years of administrative experience. Please use the link below to access and complete the survey by April 15, 2022.

Survey Link: https://forms.gle/6do8QguWT8Pzsed56

Thank you in advance for your time and participation in this study. If you have questions about this survey, the study, or your rights as a participant, please contact me by email at janelnpaschall@stu.bakeru.edu, 913-265-9210 or my major advisor, Dr. Susan Rogers, at srogers@bakeru.edu.

Sincerely,

Janel Paschall
Baker University Doctoral Candidate