SCIENCE INSTRUCTION IN A CULTURE OF HIGH-STAKES ASSESSMENT: A TRANSCEndental Phenomenological Study Into the Experiences of Missouri Elementary School Teachers in a Non-Assessed Grade Level

by

April Dawn-Nell Williams

Liberty University

A Dissertation Presented in Partial Fulfillment Of the Requirements for the Degree Doctor of Education

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SCIENCE INSTRUCTION IN A CULTURE OF HIGH-STAKES ASSESSMENT: A
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APPROVED BY:
Daniele Bradshaw, Ph.D., Committee Chair
Nancy DeJarnette, Ed.D., Committee Member
Jamie Burkhart, Ed.D., Committee Member
ABSTRACT

The purpose of the transcendental qualitative phenomenological research is to describe the characteristics and strategies of teachers who share the same experiences in teaching science, a non-assessed content, in a high-stakes assessment environment at the third and fourth grade levels. Teacher curriculum choices are dictated by the need to prepare students to take content area standardized assessments in the grade level taught. Science instruction that focuses on scientific reasoning may lead to Science, Technology, Engineering, and Math (STEM) careers for students. Teachers who elect to teach science at the elementary level in a manner that develops scientific reasoning are an anomaly in the high-stakes assessment culture. Participants are Missouri public education teachers of third and fourth grade. Interviews, artifacts, and schedules reveal the essence of teachers who teach science in a grade level not assessed on state assessments. The outcomes reflect the experiences of the teachers involved in the phenomenon. The conclusions identify strategies for teachers to increase time in science instruction and to identify next steps for administrators and educational policy makers.

Keywords: science, STEM, teachers, inquiry, instruction, high-stakes assessment
Dedication

I would like to dedicate this research to the people in my life who have enriched my life. My husband has supported me as I pursued my educational goals. He has been my partner in all of life’s dreams. My children have always made me feel humbled by their faith and support of me. I would also like to include my grandmothers. I miss them daily and I wish I could share this accomplishment with them. Throughout my life, it was my Abuelita who showed me the value of working hard and loving my family. My Granny encouraged me to reach for my goals and she provided an example of perseverance. The faith, love, and support of my family forever changed me.
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I would like to acknowledge several individuals who influenced the writing and completion of my dissertation. My daughters, Violet and Shea have always been science brained. It was because of them that I first began wondering about science instruction. They have played “mom” during intensives and when I was busy writing. I am thankful for their support and helping hands.

My husband filled in and did the other tasks so I could research and write. It has been a long journey and his support has helped me to accomplish my educational goals. I appreciate our lives together.

I would like to thank my committee members. Dr. Bradshaw, Dr. DeJarnette, and Dr. Burkhart. They have been wonderful to work with. I appreciate the support and encouragement through the entire process.

I would like to thank the teacher participants in the research study. These participants shared their experiences with me and spoke with candor about science instruction in Missouri elementary schools. I am thankful that they trusted me to tell a part of their story.
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List of Abbreviations

Adequate Yearly Progress (AYP)
Common Core State Standards (CCSS)
Education of the Handicapped Act (EHA)
Elementary and Secondary Education Act (ESEA)
End of Course (EOC)
English Language Arts (ELA)
Every Student Succeeds Act (ESSA)
Grade Level Expectations (GLEs)
Individuals with Disabilities Education Improvement Act (IDEA)
Institutional Review Board (IRB)
Inquiry Based Learning (IBL)
Local Educational Agency (LEA)
Missouri Assessment Program (MAP)
Missouri Department of Elementary and Secondary Education (DESE)
Missouri Learning Standards (MLS)
Next Generation Science Standards (NGSS)
National Science Teachers Association (NSTA)
No Child Left Behind (NCLB)
Response to Intervention (RTI)
Science Teaching Efficacy Belief Inventory-A (STEBI-A)
Science, Technology, Engineering, Arts, Math (STEAM)
Science, Technology, Engineering, Math (STEM)
Zone of Proximal Development (ZPD)
CHAPTER ONE: INTRODUCTION

Overview

The purpose of this phenomenological study was to describe the characteristics of elementary teachers who feel limited in their curricular choices when teaching science in grade levels that are not assessed on a high-stakes assessment. The historical background of the current American educational culture illustrates the foundation of the problem, the implications of the assessment centered culture on the curriculum choices of elementary teachers. In particular, the impact on non-assessed content areas is described and specifically the impact on science instruction at the elementary grade levels. The problem was defined as the impact of the current educational culture on elementary science instruction and how teachers respond to the educational culture when planning curriculum. Additionally, the significance of the study was highlighted as a means of discovering the essence of the lived experiences of teachers who choose to teach science at a grade level that is not assessed in the content area in a high-stakes assessment culture. In Missouri, third and fourth grade students take state assessments but not in science (Missouri Department of Elementary and Secondary Education, 2015). Guiding research questions were framed to guide this qualitative phenomenological study into discovering the essence of the experiences of the Missouri elementary teachers who feel passionate about science in a grade level at which the content is not assessed. Examination of the phenomenon sought to identify teacher characteristics, beliefs and strategies.

Background

The public-school system in the United States is the venue by which society addresses the concerns and problems of the day. Legislation was set at the state and national level to impact not only the curriculum and instructional practices, but to also address health and wellness,
character development and other societal issues. Public education serves the purpose of uniting the nation, a practice which began after the Revolutionary war when “a common set of cultural and social experiences in order to appreciate the concepts of nationhood” (Parkerson & Parkerson, 2008, p. 117) was needed. The educational culture has historically been a means of connecting citizens through shared educational experiences designed to meet the societal needs of Americans.

In 2001, No Child Left Behind Legislation (NCLB) was passed through the reauthorization of the Elementary and Secondary Schools act. The purpose of NCLB legislation was to increase public school accountability to educate all students as well as to close achievement gaps between subgroups (United States Department of Education, 2003). Annual targets were set for student to obtain a proficient level on the state assessments and schools faced accountability measures for not meeting the annual targets. The academic targets were set for the content areas of math and reading. Failure to meet the achievement level caused a district or local schools to fall into Needs Improvement which required additional training and the potential restructuring of the district in an attempt to improve achievement in the targeted academic areas (No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002)). State assessments became known as high-stakes assessments as the results became the “main criteria by which student knowledge, teacher efficacy, and school quality are assessed” (Thompson & Allen, 2012, p. 218). A teach to the test mentality: “the widespread use of standardized testing at all grade levels and the specter of high-stakes testing for college admission [which] continue to reinforce traditional views of learning and teaching” (Windschitl, 2002, p. 135) became prevalent. The gap in the literature is a study to understand the essence of teachers in grade levels, who feel
passionate about science but feel limited in their science instruction in the elementary classroom as a non-assessed content area.

**Situation to Self**

As a means of eliminating “suppositions and raising knowledge above every possible doubt” (Moustakas, 1994, p. 26), I epoche out or “eliminate suppositions” (Moustakas, 1994, p. 26) by identifying my interests and biases. I conducted this research because I am interested in meeting the learning needs of students and preparing K-12 students to attain their full potential whether that is in preparation for college or career. Also, I developed an interest in Science, Technology, Engineering, Art, and Math (STEAM) strategies of learning. Upon informal anecdotal investigation of elementary instruction in Missouri, it was noted that an increasing number of elementary classrooms have cut science instruction as a result of high-stakes assessment as teachers believe there is “not sufficient amount of time to incorporate science into the curricula” (Stachler, Young, & Borr, 2013, p. 15). I believe integration of science into the elementary classroom is a precursor to specific strategies for STEM and or STEAM integration. A personal urgency developed to understand why some teachers choose to include science curriculum daily at elementary grade levels that are not assessed in the content area.

As the instructional and instructional technology coach for a local educational agency, my interest was in discovering the characteristics of teachers implementing science in the elementary classroom, in order to identify and discover those characteristics amongst the teachers with whom I serve. Additionally, I wanted to be able to express strategies for integrating science in the elementary classroom within the high-stakes assessment culture to promote STEM or STEAM. The research conducted was in my home state of Missouri. Teacher participants and
the research sites were selected from “participants who volunteered” (Moustakas, 1994, p. 110) who have experiences with the phenomenon.

In order to disclose personal bias, I identified that I have a biblical world view which strongly influences my own educational philosophies and practice. I stated the belief that each student should be afforded opportunities to enter into learning and demonstrate knowledge in accordance with his or her talents. I also noted the believe that “having gifts that differ according to the grace given to us, let us use them” (Romans 12:6, English Standard Version). Hence, I believe all gifts have value and relevance for the classroom. Therefore, students should be afforded opportunities to use them. By extension then, all content areas have value and relevance in the classroom.

In addition to a bias for inclusion of all students and content areas in learning at all grade levels, several assumptions guided the research. One of my assumptions was that teachers were making curriculum choices based on what they perceive to be in the best interest of students in developing college and or career readiness in science as they implement the state standards. It was also an assumption that teachers who include science instruction in a grade level that is not assessed on a high-stakes assessment perceive the inclusion of the content is in the students’ best interest for growth in the content area. Another assumption was that teachers who elect to include science content into the elementary classroom in grade levels that are not assessed on a high-stakes assessment are not motivated by a teaching to the test philosophy of curriculum design. However, they may have felt limited in their science instruction.

A theoretical assumption was that science learning grounded in experiential activities allows students to construct knowledge and understanding of the scientific method and experimentation. I viewed this study through a social constructivism positivist paradigm which
relies “on the participants’ views of the situation” (Creswell, 2013, p. 25) and guides the research study as well as posits that “learning is constructed by the learner through social interactions” (Kirch, 2014, p. 244). The theory was extrapolated to adult learners who also construct meaning and knowledge through social interactions just as children construct knowledge. Another philosophical assumption was that knowledge is developed through critical and creative thinking processes, such as those found in science inquiry. Additionally, the theoretical assumption was that teachers who choose to implement science at a grade level in which the content is non-assessed do so because they have a Growth Mindset (Dweck, 2006) in regards to their own learning and the learning of their students.

Analysis and consideration for the axiological assumptions or values and biases was controlled by an open discussion of my own interpretation and how it connects with the interpretations of the participants (Creswell, 2013). Furthermore, the epistemological assumptions were considered in the study through the identification of self-reporting comments made by the participants about their knowledge in the field. These comments were cross-referenced with the information from the administrator survey. I also considered the rhetorical assumptions utilizing the same method of using quotes made by the participants to identify the rhetoric that frames their educational practice.

**Problem Statement**

Evolution of the current educational culture which began following America’s increased involvement in global affairs following WWII and continued through the Cold War to the CCSS, changed the public education system. The No Child Left Behind Legislation, (No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002)), designed to increase public school accountability to educate and close achievement gaps caused unanticipated results, as focus
turned to tested content areas and some schools “eliminated the teaching of science . . . because of policy related to annual [sic] yearly progress” (Johnson, 2011, p. 45). Thus, a problem arises in designing elementary classroom curriculum which meets all expectations and standards while meeting learning needs of students in all content areas. Literature focused on the significance of high-stakes assessment has been completed in regards to No Child Left Behind (2001); however, there are limited studies since the introduction of CCSS and NGSS as well as the STEM focus and there is a need for a study in regards to the perceptions and mindset of teachers who implement non-assessed science in the elementary classroom. Review of current literature has not uncovered studies designed to understand the phenomenon of an elementary teacher who elects to incorporate authentic inquiry science education in a grade level where the content is not assessed. A gap in the literature has been revealed by a dearth of studies of Missouri public elementary school teachers who teach science in an educational culture focused on ELA and math content instruction. Exploration of the phenomenon of third and fourth grade Missouri teachers to articulate the beliefs, strategies, and characteristics which guide them to include science instruction in an assessment driven culture will fill this gap in the literature. The problem is a lack of illumination into the beliefs and characteristics of Missouri elementary teachers who teach science in an educational culture focused on math and ELA.

**Purpose Statement**

The purpose of the transcendental phenomenological study was to describe the experiences of Missouri elementary teachers who choose to teach science in a high-stakes assessment environment in a grade level where the content is not assessed. Instructional strategies based on assessments are identified as “teacher-centered” (Au, 2007, p. 4). At this stage in the research, not *teaching to the test* will be generally defined as teaching a subject that
is not tested. The theory guiding this study was constructivist theory by Inhelder and Piaget (1958) and Vygotsky (1978) as a foundation for a student-focused approach to learning. Additionally, the study was translated through a growth mindset theory “based on the belief that your basic qualities are things you can cultivate through your efforts” (Dweck, 2006, p. 7). Teachers who “preached and practiced a growth mindset . . . focused on the idea that all students could develop their skills” (Dweck, 2006, p. 66). The phenomenon of elementary Missouri teachers electing to teach science was translated through the growth mindset theory.

**Significance of the Study**

The significance of the study had practical application at the LEA and classroom level through the articulation of strategies, beliefs, and characteristics which support the inclusion of authentic science instruction at the elementary grade levels. Furthermore, identification of strategies, beliefs, and characteristics allowed third and fourth grade teachers to utilize a growth mindset to expand on current classroom practice to provide science inquiry instruction as a non-assessed content in an education culture focused on assessments and accountability.

This study filled a gap in the literature and added to the empirical body of knowledge the strategies, qualities, and characteristics of teachers who utilize inquiry science instruction in the elementary classroom. "A distinguishing feature of inquiry instruction is the use of tasks that are authentic to the discipline of science” (Harris & Rooks, 2010, p. 234). The essence of the phenomenon of choosing to teach science in a high-stakes assessment culture in an elementary grade level that is not assessed was discovered. Studies explored high-stakes assessment and the impact on the classroom as well as science inquiry. However, no study examined the perceptions of teachers who choose to implement science instruction in the elementary classroom in a non-assessed by high stakes assessment content area.
The study added to the theoretical body of knowledge to detail the mindset of teachers who implement science at the elementary level in grade levels that are not assessed on a state assessment. The growth mindset was one in which people continue to challenge themselves and “allows people to thrive during some of the most challenging times in their lives” (Dweck, 2006, p. 8). The theories which framed the study include constructivist theory (Inhelder & Piaget, 1958; Vygotsky, 1978) that posits knowledge is built or constructed through experiential learning and that learning is developed collaboratively as one explores diverse perspectives as described by Relational Ontology Theory (Kirch, 2014; Vedenpaa & Lonka, 2014). The significance of the phenomenon was the identification of the characteristics of teachers who elect to teach science on a daily basis even though they are not compelled by a need to perform at particular levels on a state assessment. Further, the study expands the understanding of the phenomenon by discovering the mindset, instructional strategies, beliefs and characteristics of teachers who teach science on a daily basis using authentic scientific methods in an educational context where science is not assessed on a state assessment nor are there any specific time requirements for the amount of science instruction provided at the elementary level on a daily basis.

Research Questions

Essential and guiding questions provided focus to structure the study and data analysis. The essential question or “central question is a broad question that ask for an exploration of the central phenomenon” (Creswell, 2014, p. 139). Sub-questions provided clarity by narrowing the focus of the question to guide the study.
Central Question

1. What are the experiences of elementary teachers in Missouri who chose to include instruction using authentic inquiry-based science content instruction in an educational cultured centered on assessment in math and ELA?

The foundation of this central question was found in the growth mindset; “people with the growth mindset know that it takes time for potential to flower” (Dweck, 2006, p. 28). Science is assessed beginning at the fifth-grade level in the state of Missouri (Missouri Department of Elementary and Secondary Education, 2015). Teachers of grade levels who are not assessed in science, but have chosen to include science instruction focused on inquiry and experimentation for experiential learning understand that it takes time for students to construct knowledge and learn content skills and processes. Science inquiry instruction is defined in this study as authentic problem-solving, hands-on activities, scientific exploration, and project based learning through which students are able to construct their own knowledge (Areepattamannil, 2012; Furtado, 2010; Nowicki, Sullivan-Watts, Shim, Young, & Pockalny, 2013; Taylor & Bilbrey, 2015). The question aims to answer how or if teachers utilize the awareness that “growth-oriented teaching unleashes children’s minds” (Dweck, 2006, p. 193), by examining the experiences of elementary teachers of third and fourth grade in teaching science using inquiry methods.

Sub Questions

1. What are the beliefs of Missouri teachers choosing to teach science in non-assessed grades?

The high-stakes testing environment includes provision to monitor teacher effectiveness in the classroom through performance on state assessments. This is a fixed mindset because “one test – or one evaluation – can measure your forever” (Dweck, 2006, p. 26). Whether the pressure
is coming from the state, district, or building leadership “the current high-stakes testing movement has made standardized test scores the main criteria by which student knowledge, teacher efficacy, and school quality are assessed” (Thompson & Allen, 2012, p. 218).

Understanding the challenges teachers face to provide instruction focused on test results was essential to understanding the experiences of teachers who include science instruction using scientific processes and inquiry rather than focusing solely on the assessed content areas.

2. What are the strategies teachers take to provide authentic science instructional format to teach Missouri Learning Standards?

This question was designed to understand how science is taught in classrooms where teachers have chosen to include an inquiry based science program. In 2008, the State of Missouri provided grade level expectations (GLEs) in the area of science for public education students in kindergarten through 12th grade (Missouri Department of Elementary and Secondary Education, 2015). The standards are articulated to include the scientific process and encourage inquiry. However, no state mandates are made for the instructional practices to address and monitor the GLEs in Kindergarten through fourth grade. It is left to the individual LEAs and teachers to determine the instructional strategies and time devoted to science content instruction. The identified strategies will add to the understanding of the values and beliefs of the teacher and the experiences of students in the classroom. Foundationally, growth mindset and constructivist approaches support elementary classrooms to incorporate and learn science through skills associated with the content. In light of the demands of high stakes-assessments science instruction varies across classrooms “as individual teachers decided how much time to devote to these subjects, the content of the curriculum, and the instructional methods to use” (Wills & Sandholtz, 2009, p. 1077).
3. What are the characteristics of teachers who do not only teach to the test, as evidenced by teaching science in a non-assessed grade?

Identification of the characteristics of teachers who are not motivated by the teach to the test mentality was crucial to understanding how these teachers step outside of current educational climate to make autonomous curricular decisions “professional autonomy enables teachers to make curricular and instructional decisions to meet the diverse needs of students in their classrooms” (Wills & Sandholtz, 2009, p. 1068). Definition of characteristics of these elementary teachers will expand the understanding of how curricular decisions are made in the context of the educational culture. It was anticipated that a growth mind set, which is “a deep desire to reach in and ignite the mind of every child” (Dweck, 2006, p. 202) motivates teachers, who incorporate an inquiry-based science program in a grade level which is non-assessed in the content area to incorporate the diverse interests of and foster curiosity in all students.

**Definitions**

In order to develop a shared understanding of the phenomenology, it was essential to include a definition of key terms utilized in the research process.

1. **21st Century Skills** - 21st Century skills include critical thinking skills, creativity, and innovation, problem-solving and collaborative ethical interactions with others utilizing current technologies (Association for Supervision and Curriculum Development, 2008).

2. **Authentic Science instruction** – Authentic science instruction is defined as “using inquiry pedagogy [which] engage students in genuine scientific exploration” (Nowicki et al., 2013, p. 2).

3. **Common Core State Standards (CCSS)** - The Common Core State Standards (CCSS) are written standards for students in grades K through 12 in English Language Arts (ELA),
literacy and math designed to prepare students for college and career (National Governors Association Center for Best Practices & Council of Chief State, 2010).

4. *Every Child Succeeds Act (ESSA)* – The purpose of the Every Child Succeeds (ESSA) Act (2015) legislation is “to provide all children significant opportunity to receive a fair, equitable, and high-quality education, and to close educational achievement gaps” (Every Student Succeeds (ESSA) Act, 2015, Sec. 1001).

5. *Growth Mindset* - Growth mindset is “the belief that your basic qualities are things you can cultivate through your efforts” (Dweck, 2006, p. 7).

6. *High-Stakes Assessment* – High-stakes assessments are standardized assessments whose results became the “main criteria by which student knowledge, teacher efficacy, and school quality are assessed” (Thompson & Allen, 2012, p. 218).

7. *Horizontalizing* - Horizontalizing is when a researcher considers data by “regarding every horizon or statement relevant to the topic and question as having equal value” (Moustakas, 1994, p. 118).

8. *Literate* - Literate refers to the ability to “focus on skills such as higher order thinking, deep knowledge, substantive conversation and connections outside of the classroom” (Moorehead & Grillo, 2013, p. 51).

9. *Next Generation Science Standards (NGSS)* – The Next Generation Science Standards (NGSS) are standards written by the National Academy of Science based on the science that students should know from kindergarten to 12th grade (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

school accountability to educate all students and to close achievement gaps for ethnicities and other subgroups.

11. **Pedagogy** – Pedagogy is a word which means, “leading a person to knowledge” (Gutek, 2011, p. 458).

12. **Proficiency** – Proficiency is the academic measure or point at which “a student is determined to be sufficiently educated at each grade level and upon graduation” (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010, para. 2).

13. **Professional Autonomy** - “Professional autonomy enables teachers to make curricular and instructional decisions to meet the diverse needs of students in their classrooms” (Wills & Sandholtz, 2009, p. 1068).

14. **Response to Intervention** – Response to Intervention (RTI) is a tiered approach to provide “early intervention to all children at risk for school failure” (Fuchs & Fuchs, 2006, p. 93).

15. **Science instruction** - Science instruction in the literature is identified as using inquiry pedagogy to “engage students in genuine scientific exploration” (Nowicki et al., 2013, p. 1136).

16. **Scientific inquiry** - Science inquiry applies knowledge to real-world problems to help students understand the outside world through encouragement to use inquiry and to accept those answers that are supported by evidence (Bruce-Dais et al., 2014; Engeln, Euler, & Mass, 2013).

17. **Self-Contained classroom** - A classroom in which “the children are taught all subjects by one teacher” (Lobdell & van Ness, 1963, p. 212).
18. **STEAM** – STEAM is the integration of arts with STEM designed to develop creativity and innovation that will help build new jobs and industries (White, 2010).

19. **STEM** - Dr. Judith Ramaley defined STEM in 2001 as “an educational inquiry where learning was placed in context, where students solved real-world problems and created opportunities for the pursuit of innovation” (Daugherty, 2013, p. 10).

20. **Superintendent** – The Superintendent is the “school board’s chief executive officer [who] possesses a position of high visibility within the community that is both practical and symbolic” (Razik & Swanson, 2010, p. 382).

21. **Teach to the Test** - Teach to the test is a teaching mentality developed from “the widespread use of standardized testing at all grade levels and the specter of high-stakes testing for college admission [which] continue to reinforce traditional views of learning and teaching” (Windschitl, 2002, p. 135).

**Summary**

The American educational accountability measures No Child Left Behind (No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002)) and CCCS (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010) shaped the current educational culture. With the future impact of ESSA (2015) unclear, the need to understand elementary science in a culture of accountability remains (Every Student Succeeds (ESSA) Act, 2015, Sec. 1001). Furthermore, the articulation of the need for college and career preparedness through STEM learning highlighted a curricular problem as teachers focus on assessed content areas in the elementary grade levels rather than the development of science knowledge and skills systematically and developmentally across all grades. A transcendental phenomenological study to explore the characteristics of teachers who incorporate science in the
elementary grade levels that are not assessed by high-stakes assessments was required to enrich understanding.
CHAPTER TWO: LITERATURE REVIEW

Overview

Education establishes the foundations for college and career readiness; an outcome that is the focus of K-12 educational agencies with the ultimate outcome being for students to take their place in society. In particular, recent educational focus has been on 21st Century skills as well as preparing students for Science, Technology, Engineering, and Math (STEM) career fields. The STEM fields have been identified in the news and current discussions of educational standards as educational priorities either as the primary STEM fields or with the inclusion of the arts with Science, Technology, Engineering, Arts, and Math (STEAM). According to the National Council of Science, “the need for science and engineering professional to keep the United States competitive in the international arena” (National Research Council, 2012, p. 7) has been at the root of science education improvements. The science education improvements centered on K-12 Local Education Agency’s (LEA) implementation of the STEM content areas into the K-12 classroom to prepare students for future career paths may require teachers to make a pedagogical shift to teach science utilizing process skills as well as content knowledge standards through the integrated STEM/STEAM curriculum model.

Traditionally, it is considered that STEM disciplines appeal to students with strengths and interests in particular content areas. Inclusion at the elementary level, may develop student interest in science and STEM as “recent evidence [identifies] that children’s life-world experiences prior to 14 are the major determinant of any decision to pursue the study of science” (Archer et al. 2010, p.168). The question raised is how to implement the STEM career fields in a manner which will appeal to and entice students from both genders and all ethnicities equally to the career fields and is one challenge of STEM integration (Stachler et al., 2013). Response to
Intervention (RTI) is “early intervention to all children at risk for school failure,” (Fuchs & Fuchs, 2006, p. 93), differentiation of learning and instructional practices born from No Child Left Behind (2001) legislation and accountability measures to ensure all students are learning and growing academically have focused educator attention on meeting the diverse learning needs of students in the assessed content areas. Teachers must also consider how to utilize strategies to differentiate content instruction to encourage subgroup interest in STEM contents. Science instruction in the elementary grades for process and knowledge are needed “in the interest of developing our nation’s future STEM innovators” (Cotabish, Robinson, Dailey & Hughes, 2013, p. 215). Analysis of the current educational high-stakes accountability culture reveals an elementary curricula challenge to the implementation of science content in the elementary classroom which translates to a challenge in implementing a STEM focus in the elementary classroom.

The age of accountability and standardized assessment has resulted in an educational system which values primarily the core content areas assessed at each grade level. Daily classroom schedules are designed to maximize instructional time in the assessed content areas with time being diverted from non-state-assessed content areas to spend more time in remediation and enrichment of the assessed content areas, English Language Arts (ELA) and math. The focus on test preparation limits the time spent on content areas other than ELA and Math. Districts, administrators, and teachers make curricular decisions based on accountability measures and are influenced by goals for student progress toward educational gains which will result in increased proficiency on state assessments. Teachers in the elementary building are focused on preparing students for state assessments which begin in the third grade. At the elementary, third and fourth grade levels, in Missouri, science is not an assessed content area
Science is taught through ELA using informational text to address science grade level expectations (GLEs). The amount of time spent on the inclusion of science and the teaching strategies utilized is an LEA and/or individual teacher decision. In as much, not all teachers are making the same curricular choices and only some teachers choose to teach authentic science through the use of the scientific method and exploration as a part of their learning strategy (Bernhardt, 2015; Isikoglu, Basturk, & Karaca, 2009; Nadelson et al., 2013). Questions arise as to why teachers are making different curriculum decisions in the area of science in the state of Missouri if all elementary teachers are held to the same state guidelines and expectations. The impact of the upcoming changes to the MLS in science and ESSA on the implementation of science in the state is as yet unknown. Nor is it clear if or how teachers may plan instruction that retains focus on high-stakes assessment with a dual goal of decreasing the overall time spent in state assessments. This results in questions about the experiences of Missouri elementary teachers and if those who teach science using authentic methods with regularity do so because of a shared set beliefs or characteristics and how districts might utilize this knowledge about these teachers to change science instruction in the state.

The purpose of this qualitative phenomenological study was to determine the experiences of teachers who choose to teach science in a high-stakes assessment environment at a non-assessed grade level in the content area. The theoretical framework guiding the study is examined and described through the review of current literature in the areas of science instruction, curriculum development, and inquiry which extend understanding of the phenomenon. Additionally, suggestions for future research are explained.
Theoretical Framework

The theoretical framework of the study supports the purpose to discover the essence of teachers who are involved in the phenomenon of teaching science in elementary grade levels which are not accountable to the content. The theoretical framework guiding the study is based on the theories of Social Constructivism (Vygotsky, 1978), Relational Ontology (Vygotsky, 1978) and Growth Mindset Theory (Dweck, 2006). Together, these theories provide a theoretical basis for the understanding the experiences and mindsets of participants in the study and analysis of current literature and research.

Social Constructivism

The study was framed by Vygotsky’s 1978 Social Constructivism Theory, teachers construct knowledge through social interactions, in the same manner as students. The Social Constructivism Theory frames the study through the lens of social constructivism to develop understanding of the observations and data observed to define themes and concepts. The concept that knowledge is built from “learning how to successfully interact” (Allen & Bickhard, 2011, p. 165) with the world is the root of the constructivist theory. John Piaget is one of the theorists from whom the theory of constructivism originated (Allen & Bickhard, 2011; Kirch, 2014). The theory serves as a framework for examining how students and teachers learn, starting at the current point of knowledge and then challenging their learning to work within the Zone of Proximal Development (ZPD), as verbalized by Vygotsky (1978), which explains the concept that learners learn when educators provide just enough support and scaffolding with in the zone to challenge learners in ways which allow them to construct and grow in knowledge without hitting the frustration stage. The ZPD is, “the distance between the actual development level as determined by independent problems solving and the level of potential development” (Vygotsky,
1978, p. 86) when working with teachers and/or peers. This concept connects to the theoretical assumption that science is an experiential inquiry learning experience and teachers choosing to teach science in a social constructivist manner is not consistent with a teach to the test philosophy. Constructivist learning and student-centered teaching methods have similarities with science inquiry: “curiosity, inquisitiveness, autonomy, independence of mind, freedom from external authority, and a personal search for meaning about the world are the qualities that scientists possess” (Deboer, 2002, p. 407). The theory allows for the consideration that individuals learn knowledge through experiences and how they respond to those experiences. Constructivist approaches to learning are centered on the ideals that learning occurs through metacognitive acts such as active thinking, reflecting on, revising or reinforcing their own thinking, actions, and beliefs through social interactions (Kirch, 2014; Minner, Levy, & Century, 2010). Social constructivism serves as a basis for examining the thoughts and actions of teachers as they plan curriculum for the elementary classroom through the knowledge they have constructed through social interactions, experiential learning, and professional collaboration with colleagues. The Social Learning Theory articulates that, “human learning presupposes a specific social nature and a process by which children grow into the intellectual life” (Vygotsky, 1978, p. 88). Constructivism provides a framework to examine current literature to define science instruction and the methods selected by teachers for the inclusion of science in the elementary classroom.

**Relational Ontology**

The study will also be developed through the framework of relational ontology (Vygotsky, 1978) as participants share their viewpoints which have been shaped by the educational culture, administration, and colleagues who interact with them. Vygotsky’s (1978)
theories of relational ontology in conjunction with and as a part of constructivism is the idea that there are multiple perspectives of reality. Examining the perspectives of educators who have experienced the phenomenon will uncover the educational realities of third and fourth grade teachers who have elected to incorporate daily science instruction in the elementary classroom in a high-stakes assessment culture. Learners interact with others in social situations who hold differing viewpoints and backgrounds. Vygotsky (1978) articulated a learning theory based on a cultural development viewpoint. The relational ontology theory is the idea that learning is a social activity as individuals interact with peer groups and between generations (Kirch, 2014; Vedenpaa & Lonka, 2014). Within the theory is an independence and autonomy in learning for students to develop individually while they engage socially with one another to build knowledge in the classroom. Each learner constructs knowledge by having their viewpoint refined by interactions with the group. This theory informs the qualitative study as teachers involved in the phenomenon interact with peers and administrators in the educational system and this interaction shapes their own independence in learning. Although they share and connect with one another and make the cumulative knowledge of the team available to each member through those interactions, the learning may differ from person to person. The idea of utilizing collaborative learning to refine and sharpen ideas while retaining individuality is an underlying theory of the perceptions of students’ best interest in making curricular choices by teachers within a state system. The relational ontology theory will inform the analysis of themes and codes in the discussion of the data.

**Growth Mindset**

Finally, the Growth Mindset Theory (Dweck, 2006) will also be used as a frame for the study to uncover the mindset of teachers involved in the phenomenon for themselves and in
curricular planning. Along with the idea that individuals bring differing viewpoints to interactions and that knowledge is constructed through social connections and interactions, a growth mindset is “about learning something over time: confronting a challenge and making progress” (Dweck, 2006, p. 24). The theory serves as a basis for this study examining the lived experiences of teachers who incorporate science instruction daily in grade levels where the content is non-assessed. Identification of the mindset of teachers involved in the phenomenon will add to understanding the characteristics and beliefs of teachers who are not accountable for science instruction but choose to implement science at a non-assessed grade level in the content area. Individuals who have a growth-mindset view a single assessment as having “little value for understanding someone’s ability, let alone their potential to succeed in the future” (Dweck, 2006, p. 29). It is hypothesized that curricula decisions of teachers with a growth mindset are anticipated to not be motivated by a teach to the test philosophy, but by a growth mindset. Moreover, this theory plays a role in discovering the characteristics of teachers who are not motivated by test preparation but rather make curricular decisions based on their beliefs about how to grow student abilities. Furthermore, it is anticipated that a teacher who implements science at a non-assessed grade level understands learning progressions as well as the content knowledge which students will find necessary to utilize and build deeper understanding of science content and process knowledge. Teachers with this mindset understand that “test scores and measures of achievement tell you where a student is, but they don’t tell you where a student could end up” (Dweck, 2006, p. 66). The theory establishes a framework for understanding teacher reaction to high-stakes assessment and the strategic planning that occurs in the classroom.
A theoretical framework that is comprised of Social Constructivism (Vygotsky, 1978), Relational Ontology (Vygotsky, 1978) and Growth Mindset Theory (Dweck, 2006) will provide the structure to understand and discover the experiences of teachers who teach an authentic inquiry science methodology, to students in a grade level that is not assessed in the content area, in a culture of high-stakes assessment. Questions asked during interviews and on questionnaires will be explained in accordance with these theories. Data analysis will also be completed through the theoretical lens of Social Constructivist, Relational Ontology and Growth Mindset Theory.

**Related Literature**

A review of current literature revealed and clarified the high-stakes assessment educational culture in the United States and its influence on science instruction in the elementary classroom. The search terms utilized include high-stakes assessment, standardized assessment, science education, science, elementary classroom, inquiry learning, STEM and STEAM, professional learning, and integration used in database searches as single and combined search terms. Current literature reviewed included studies conducted in the United States to develop an understanding of authentic science instruction and inquiry. Additionally the studies examined both teachers’ and pre-service teachers’ beliefs about science inclusion and instruction in the classrooms. Research utilized included studies from early childhood through preparation of pre-service teachers at post-secondary institutions.

The databases searched include Academic Search Complete, Education Research Complete, ERIC and Google Scholar. Literature was examined between the dates of 2001 and 2016. The dates utilized were selected to develop an understanding of the development of the current educational culture as well as to capture the educational impact of increased accountability on science instruction as framed by national legislation. International articles were
not eliminated but were analyzed to add to the understanding of inquiry in the classroom as well as an understanding of the state of science globally. Abstracts were then considered for value in addressing the construction of knowledge around inclusion of science in the elementary classroom during grade levels at which the content is not assessed with high stakes assessments. However, the grade levels were involved in high stakes assessment in other content areas. Sources of information that were quoted in the initial research were sought out to develop a deeper understanding of the background and current literature. These sources were sought even if they did not fall within the 2001-2016 dates, but were evaluated for how they would add to the understanding of strategies and terminology to determine if inclusion was meaningful and would add to the understanding of the phenomenon. Additionally, the impact of assessment on current educational practice was researched and these terms were searched in combination with Missouri. Science instruction standards, both current and future, and guidelines, in the state of Missouri, were also examined. After analysis of the articles, a need to identify the beliefs, characteristics, and strategies of Missouri elementary teachers who are not motivated to make science curricular choices based on a teach to the test framework was determined. Current literature synthesized includes both qualitative and quantitative studies. Popular and best practices literature sources were not included in the literature review. However, they were utilized to set the stage as well as to develop an understanding of the current educational climate.

A review of current literature revealed the dichotomy between inclusion of science in elementary classroom instruction and accountability to state assessments and federal expectations. Furthermore, the focus of recent aims and legislation has been to “prepare a scientifically literate national work force that is prepared to compete in an increasingly scientifically and technologically oriented global economy” (Milner, Sondergeld, Demir,
Johnson & Czerniak, 2012, p. 112). Current literature indicates that “the educational demands of this century require novel and different teaching practices that not only align with workforce preparation, but that also embrace highly collaborative project–based learning environments” (Bernhardt, 2015, p. 1). However, in the age of accountability teachers who spend much of their time preparing for assessments “were more likely to use teacher-centered practices such as textbooks, multiple-choice questions, supplementary materials, textbook-based assignments, and worksheets” (Vogler, 2008, p. 12). Whereas, science inquiry and experimentation were associated with student centered activities, which utilized collaborative and project based instruction and were not learning activities associated with being focused on test preparation. Therein, student centered activities are associated with science inquiry and project based learning tasks. In these tasks, “teachers design and monitor instruction so that students become increasingly conscious of their own and others’ ideas” (Qablan & DeBaz, 2015, p. 5). The literature reviewed highlighted two areas; influence of high-stakes assessment on curricular development and instruction and inclusion of science instruction. Also, the articulation of science instruction which supports the development of science content area knowledge and processes was described.

**Current Educational Culture**

The current educational culture began to evolve following the 1947 Truman report on education and America’s involvement in the Cold War. The reliance on an education citizenry focused the attention of the country on math and science as it was taught in the public school in preparation for higher learning (Hutcheson, 2007; Johanningmeier, 2010). The report called for the public-school system to “identify and cultivate talented youth, those who were, . . . labeled as ‘gifted’” (Johanningmeier, 2010, p. 351) for further education in the areas of engineering and
science. The Elementary and Secondary Education Act (ESEA) of 1965 further changed the educational setting. While previous reports encouraged public education not to overlook the identification of talented youth from among the diverse populations, the Elementary and Secondary Education Act (ESEA) of 1965 reflected the American belief of a vision of education which provides access to knowledge and learning for students. The Education of the Handicapped Act (EHA) of 1975 enacted the legal requirement which states that “State and local educational agencies can and will provide effective special education and related services to meet the needs of handicapped children” (Education of the Handicapped Act, 1975, p. 2). The Individuals with Disabilities Education Improvement Act (IDEA) of 2004, noted the importance of improving education for students with disabilities as it was found that “disability is a natural part of the human experience and in no way, diminishes the rights of individuals to participate in or contribute to society” (Individuals with Disabilities Education Improvement Act, 2004, p. 1). Therein, the IDEA (1975) resulted in changing the educational culture to one that provided for the education of all students. It was a change from the concept of tracking students by ability and providing access to information and opportunities based on students being identified as talented or gifted to providing equal opportunities to all students. At this stage in the evolution of American education, science and engineering knowledge became accessible and was provided to students, not just those students identified as gifted.

Along with the commissions and laws focused on education, the Cold War also had an impact on the evolution of the current educational culture. During the Cold War, competition and fear propelled the United States forward in science and math education as a means of survival and to ensure the manpower to research and create advanced weaponry, technology, and health care (Johanningmeier, 2010). America recognized the importance of an educated workforce to
fulfill societal needs. In the wake of the Cold War, the *A Nation at Risk* (1983) report changed the educational conversation from competition and fear for survival to the need to be competitive in the global economy (United States National Commission on Excellence in Education, 1983). The report identified a decline in American students’ math and science scores following the Cold War fear of nuclear war, “the educational foundations of our society are presently being eroded by a rising tide of mediocrity” (United States National Commission on Excellence in Education, 1983, p. 258). Moreover, the report called the educational system to reform in order to ensure that the next generation of Americans continued the cultural legacy of the United States by being better educated than the previous generation.

In 2001, America reauthorized the Elementary and Secondary Schools act, also called No Child Left Behind Legislation (NCLB) which was designed to increase public school accountability to educate all students and to close achievement gaps between ethnicities and other subgroups (United States Department of Education, 2003). Proficiency targets were set annually for which all students were accountable on state assessments. Schools were held accountable for failure to achieve growth toward proficiency targets in reading and math. No Child Left Behind (NCLB) (2001) was designed to ensure high quality instruction in math and communication arts taught by highly qualified teachers and was made available for all students regardless of race, gender, ability or socioeconomic status. The implementation of No Child Left Behind (NCLB) (2001) continued the evolution in public education, as schools utilized instructional time to focus on assessed areas increasing time spent in those content areas to improve test scores (Au, 2007; Furtado, 2010). No Child Left Behind (NCLB) (2001) primarily focused on ELA and math, while science would be added into the accountability measures during the fourth year of the implementation.
(C) Subjects. – The State shall have such academic standards for all public elementary school and secondary school children including children served under this part, in subjects determined by the State, but including at least mathematics, reading or language arts, and (beginning in the 2005-2006 school year) science, which shall include the same knowledge, skills, and levels of achievement expected of all children. (No Child Left Behind Act of 2001, Pub. L. 107-110, 115 Stat. 1425, p. 21)

The primary focus for elementary education was accountability for reading and math scores in grades three through eight since states had four years before they were required to focus on science.

Under the No Child Left Behind Act (2001), each state developed state standards and assessments which were connected to federal accountability. Curriculum was written to meet the state standards. State standards and assessments were not the same, each state established proficiency when “a student is determined to be sufficiently educated at each grade level and upon graduation” (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010, para. 2). State assessments aligned to the state standards were developed as each state was responsible for developing their accountability measure (No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002)).

Schools were accountable to meet Adequate Yearly Progress (AYP), the annual federal district report card based on student achievement for all subgroups in math and reading. AYP was figured based on the percent of students scoring proficient or advanced on the state assessments and how students scored in relation to the target for the year. AYP was then used to determine the Local Educational Agency’s (LEA) accreditation levels and consequences ranging from additional professional learning to restructuring to loss of accreditation were levied No
Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002). The federal government mandated annual achievement levels on state standardized assessments. Failure to meet the achievement level caused a district or local schools to fall into the Needs Improvement category which would require additional training and potentially restructuring of the district in an attempt to improve achievement in the targeted academic areas (No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002)). The state assessments became known as high-stakes assessments as the results became the “main criteria by which student knowledge, teacher efficacy, and school quality are assessed” (Thompson & Allen, 2012, p. 218).

Consequences of NCLB. The implementation of NCLB had unanticipated results as “many schools across the country—particularly elementary . . .—eliminated the teaching of science and opportunities for students to have access to technology because of policy related to annual [sic] yearly progress under the No Child Left Behind Act’’ (Johnson, 2011, p. 45). Public schools in an effort to meet AYP began to devalue the contributions of other content areas such as science, social studies, and the arts in an effort to focus on math and communication arts. Contributions of non-tested content areas were deemphasized and a division among the disciplines expressed (Daugherty, 2013). The shift in focus was to ensure that academic gains, which would keep schools out of needs improvement, retain funding, and accreditation levels were achieved. One issue identified in the shift of focus to assessed content areas is a “decrease of 33% in the number of weekly minutes devoted to science instruction that came about as a result of the U.S. ‘No Child Left Behind’ Act” (Hug, 2010, p. 3). Consequently, a division among the disciplines has been noted as teachers try to improve school performance and meet accountability standards (Daugherty, 2013, p. 14). The annual targets did not measure growth of student cohorts or individual students, but rather they measured the achievement of grade level
students against the achievement of the group of students in the year immediately previous to them. The result was a shift in the focus of PK-12 schools from a well-rounded education in which each content area contributed to the development of the whole child to a curricular focus on math and communication arts also known as English Language Arts (ELA). Under high-stakes assessment pedagogy, curriculum alignment to the tested content areas was implemented with an increased level of exclusion of the non-assessed content area curriculum (Au, 2007). Yet, teachers have indicated the belief that “integrating science into their curricula would make science concepts easier for their students to understand and increase their problem-solving skills” (Stachler et al., 2013, p. 15). A quandary arose between the development of curriculum and the teacher philosophy. States were provided the opportunity to apply for competitive Race to the Top funding to improve education at the state and local levels in exchange for adoption and transition to the new standards and accountability systems with the only priority noted as Science, Technology, Engineering, and Math (STEM) learning. Dr. Judith Ramaley defined STEM in 2001 as “an educational inquiry where learning was placed in context, where students solved real-world problems and created opportunities for the pursuit of innovation” (Daugherty, 2013, p. 10). A conundrum developed in the educational setting as teachers had a continued need to achieve at high levels on the state assessments along with a new expectation to focus on STEM learning in the curriculum (Nadelson et al., 2013). The impact at the LEA is on curriculum development as teachers are informed by legislation and educational standards. The integration of arts with STEM designed to develop creativity and innovation that will help build new jobs and industries has become known as a STEAM philosophy of education (White, 2010).

**Common Core culture.** The year 2014 loomed as the 100% target milestone for all students to be proficient in math and communication arts practitioners felt “the NCLB's goals
were unrealistic” (Pinder, 2013, p. 301) and did not consider the needs of students. Realization that the target was unattainable by the majority of schools in the country led to changes in the national education policy. Under No Child Left Behind (2001), each state developed state standards and assessments which were connected to federal accountability. Curriculum was written to meet the state standards for each grade level. State standards and assessments were not equal, each state established proficiency or the level at which, “a student is determined to be sufficiently educated at each grade level and upon graduation” (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010, para. 2). The Common Core State Standards (CCSS) are a recent effort to unite the States in the development of a common educational experience through shared standards across state boundaries (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The CCSS are written standards for students in grades K through 12 in English language arts (ELA), literacy, and math designed to prepare students for college and career (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The CCSS include literacy standards for all content areas taught in grades six through twelve that are added to the content specific standards. Along with the CCSS, science standards known as the Next Generation Science Standards (NGSS) were developed in 2013. The NGSS are standards written by the National Academy of Science based on the science that students should know from kindergarten to twelfth grade (Next Generation Science Standards Lead States, 2013). The CCSS and NGSS were developed to provide uniformity across the states at grade levels and to create an assessment that was translatable across state boundaries and provided clear descriptions of student proficiency (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The CCSS standards expanded
the accountability for developing literate students who could solve real-world problems to all content area teachers. Literate refers to the ability to “focus on skills such as higher order thinking, deep knowledge, substantive conversation, and connections outside of the classroom” (Moorehead & Grillo, 2013, p. 51). In an effort to provide relief for states that could not attain 100% proficiency targets, states were allowed to file waivers exempting themselves from the No Child Left Behind (2001) measures if they agreed to implement the national standards also known as the Common Core State Standards (CCSS) and develop statewide accountability measures (United States Department of Education, 2013).

In December of 2015, the Every Student Succeeds Act (ESSA) was signed into law. The purpose of this legislation was noted as being “to provide all children significant opportunity to receive a fair, equitable, and high-quality education, and to close educational achievement gaps” (Every Student Succeeds (ESSA) Act, 2015, Sec. 1001). The legislation calls for states to adopt challenging standards, with math, ELA and science specifically mentioned. Additionally, the legislation allows for the state to determine the assessment plan for math, ELA, and science. Missouri provided a statement that indicates that “the act maintains the current assessment requirements which the state carries out through the Missouri Assessment Program (MAP) tests” (Missouri Department of Elementary and Secondary Education, 2016, para. 4). MAP assessment includes the assessment of math and ELA in grades three through eight and science in grades five, eight and Biology I (Missouri Department of Elementary and Secondary Education, 2015). The timeline for implementation of ESSA is the 2017-2018 school year and any future implications for assessment and science instruction in the state are unknown.

**21st century skills.** American public education legislation and standards were born from a concern and desire to prepare students in the United States to compete in the global
marketplace (Association for Supervision and Curriculum Development, 2008; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010; No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319 (2002)). Along with the CCSS, the skills necessary to compete in the global marketplace were identified. The 21st Century Skills identified as essential to the fastest growing careers, “in the United States are dependent on [the] mastery of mathematics and science knowledge and skills, and many of these positions are being filled by talent from abroad” (Johnson, 2011, p. 46). A shift occurred in teaching expectations as teachers were required to not only prepare students for high stakes assessments, but also were “charged with educating students to be successful in a complex, interconnected world” (Association for Supervision and Curriculum Development, 2008, para. 1). 21st Century skills include critical thinking skills, creativity, and innovation, problem-solving and collaborative ethical interactions with others utilizing current technologies (Association for Supervision and Curriculum Development, 2008). Teachers may also consider STEM content knowledge and skills in curriculum development for career preparedness as 21st Century Skills. Within this educational culture are the 21st Century learning skills which “makes it necessary for educators to think differently about what knowledge is considered of most value, how we gather and consume ideas, and what it might mean to provide students with authentic opportunities to meaningfully collaborate” (Bernhardt, 2015, p. 4). When making curricular decisions, teachers must consider state standards, preparation for assessment, as well as integration of skills and concepts to prepare students for college and career. With the introduction of ESSA (Every Student Succeeds (ESSA) Act, 2015) legislation, support for 21st Century learning is expanded in educational legislation.
**STEM.** As a result of the evolution of education through the legislation, accountability and technology innovations, the current educational purpose is college and/or career preparation. STEM career fields are noted to be the jobs of the future “if the U.S. is to compete with other nations, our children must be well-versed in 21st century workforce skills related to STEM education” (Daugherty, 2013, p. 10). For that reason, instructional legislation standards and practices that would assist students in developing competency in the STEM careers became not only desirable but also critical for the United States to continue to develop and compete globally. STEM is a federally supported initiative through the federal budget; billions were allocated and STEM was identified as the only competitive priority for Race to the Top grant funding in 2011 (Johnson, 2011, p. 45). STEM was designed as an integrated inquiry approach to learning in order to solve real-world problems (Daugherty, 2013). Inclusion of science instruction which in the literature was identified as using inquiry pedagogy to “engage students in genuine scientific exploration,” (Nowicki et al., 2013, p. 1136) allows the opportunity in the school day to incorporate STEM. However, a dilemma developed in the educational setting to include instructional time daily not only on assessed content areas, but also on non-assessed areas of science which could be a venue to STEM learning.

**STEAM.** STEAM is the integration of arts with STEM designed to develop the creativity and innovation to help build new jobs and industries (White, 2010). This added focus coincides with 21st Century skills which include creativity and innovation (Vedenpaa & Lonka, 2014). Therefore, the addition of the arts to create Science, Technology, Engineering, Arts, and Math (STEAM) is a multi-disciplinary integrated approach to learning that encourages student creative problem solving and innovation. STEAM is a current educational conversation as practitioners discuss STEM and its implementation in the classroom, a topic for a future study.
**Instructional time.** The current educational setting is fraught with complexity as teachers consider standards, skills, and legislation when developing classroom instruction. Another concern is with constraints between spending time on assessed content areas and the need to include science instruction. In Missouri, state assessments in science are given at the fifth and eighth grade levels (Missouri Department of Elementary and Secondary Education, 2015). While the school improvement standards denote that at the elementary level students are to receive “regular instruction” (Missouri Department of Elementary and Secondary Education, 2015, para. 2) in the core content areas such as science, English Language Arts (ELA), math and social studies, there is no definition of what constitutes regular instruction. Unlike recess and specials there are no time delimitations about the number of minutes of instruction required to be taught on a daily or weekly basis in the content areas (Missouri Department of Elementary and Secondary Education, 2013). It is left then to the school district, building administration, or individual teacher to determine what qualifies as regular instruction in the content areas and the amount of time spent teaching science content differs by elementary building and teacher across the state.

**Missouri Learning Standards.** While the state provides Missouri Learning Standards (MLS) and Grade Level Expectations (GLEs) which include eight science strands: “Matter & Energy, Force & Motion, Living Organisms, Ecology, Earth Systems, Universe, Scientific Inquiry, and Science, Technology, and Human Activity” (Missouri Department of Elementary and Secondary Education, 2008, p. 2), LEAs design curricular implementation. Revised MLS were approved in March 2016; the standards reflect both the previous Missouri GLEs and the NGSS (Missouri Department of Elementary and Secondary Education, 2015) and technology, engineering and inquiry are included in the science MLS in grades Kindergarten through fifth
grade. The LEAs develop objectives aligned to these standards and determine the educational best practices for addressing them in the classroom. As a result, the inclusion of science in the elementary classroom is “based on teacher and school initiatives” (Furtado, 2010, p. 107). The strategies used to teach science and the assessments to monitor the implementation of state elementary grade level learning standards are a LEA decision until grade five when Missouri begins to assess science and more uniformity occurs across the state and LEAs as teachers align instruction not only to standards but also to the state assessment. Science in Missouri is assessed at the fifth and eighth grade level and in the area of Biology 1 at the high school. Due to the End of Course (EOC) assessment, Biology is the only science course which all high school students are required to take in the state in order to fulfill one of the three required science credits for graduation (Missouri Department of Elementary and Secondary Education, 2015). ELA and math are the contents assessed annually beginning in the third grade.

Curriculum decisions. Curricular decisions are made daily in the classroom, many of those based on a teach to the test mentality: “the widespread use of standardized testing at all grade levels and the specter of high-stakes testing for college admission [which] continue to reinforce traditional views of learning and teaching” (Windschitl, 2002, p. 135). Teachers are on the front line of the challenge daily making curriculum choices to either teach to the test or to teach in a manner which prepares students with the knowledge they will need to be successful in the future. Additionally, in a high-stakes assessment culture, balance must be achieved between the teacher’s identity and growth mindset with the “vision of becoming a change maker [which may get] lost in the small exigencies of a test-driven context” (Agee, 2004, p. 772). It is noted that instruction at the elementary level encourages student interest in science: “Elementary teachers are the gatekeepers to fostering the gifts and talents of future STEM innovators”
Alberts (2000) posed the question, “if young people with outstanding scientific potential are never exposed to scientific inquiry and never given any illustration of what doing science is like, how can they think meaningfully about the possibility of a scientific career” (p. 10)?

**Curriculum Development**

Analysis of the studies revealed the significance of high-stakes assessment on curriculum decisions and instructional practice. Although the common core state standards (CCSS) sought to standardize grade level expectations of learning, high-stakes assessments vary by state in regards to the expectations, assessment design, and definition of proficiency (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Federal and state standards have been designed and set forth to promote scientific thinking and inquiry. (National Research Council, 2012; Next Generation Science Standards Lead States, 2013). The focus on inquiry “challenge[s] the education and science communities to transform the very heart of students’ experiences in science classrooms” (Singer, Marx, Krajcik, & Chambers, 2000, p. 165). The necessary changes to science curriculum based on the NGSS was described in the study by Marshall and Alston (2014) which identified the need for “a reshaping of past curriculum and instruction because teaching a student to remember, recall, and define is very different from teaching so that students can model complex ideas, plan, and conduct an investigation, or provide evidence-based arguments” (p. 809). Added to the current education culture is new legislation in the form of the Every Student Succeeds Act (ESSA) (2015). Future implementation of the ESSA legislation, passed in December of 2015, allows for states to design their own state assessments and define proficiency (Every Student Succeeds (ESSA) Act, 2015). The impact of the new legislation is yet to be determined as states develop their own plans to be
implemented by LEAs and which, “provide an assurance that the State has adopted challenging academic content standards and aligned academic achievement standards” (Every Student Succeeds (ESSA) Act, 2015, p. 42). Although the anticipated result of ESSA (2015) is a reduction in the percentage of time in the school year spent on assessments, teachers, administrators, LEAs, and states are still influenced by the high stakes assessment culture as they wait for state departments of education to articulate state responses to ESSA (2015).

Assessments are standardized for every child who is not on an individualized education plan which strategically plans for classroom accommodations for learning disabilities (Missouri Department of Elementary and Secondary Education, 2015). Grade level state assessments are based on standards of learning that apply to all students of the grade level; “the high-stakes assessment based on standardized scores assumes that everyone must be exactly like me in order to be successful” (Passman, 1999, p. 197). In Missouri, science assessments are given to all students at the fifth and eighth grade levels (Missouri Department of Elementary and Secondary Education, 2015). While these assessments occur at a specific grade level, they include grade level expectations (GLEs) from the grade span in order to identify students who have advanced and/or below grade level understanding of science and to represent the learning of the grade-span (Missouri Department of Elementary and Secondary Education, 2017). Thus, when a student takes a science assessment in the fifth grade, the state assessment reflects the knowledge learned during the previous two school years as well as the current school year. It is a unique situation as the teachers of the fifth grade are the ones held accountable for high-stakes assessment results and the content knowledge development and retention which occurs between grades three and five. It should also be noted that even though the assessment for science at the fifth grade is identified as a third through fifth grade span assessment, since there is no assessment given in
grades kindergarten through fifth grade, the reality is that the assessment represents the cumulative knowledge of students within the elementary instructional time period.

In the current educational culture, curriculum choices, which are mandated by state and federal guidelines as well as district administration emphasize students being prepared for state assessments. There is indication that “high-stakes tests encourage curricular alignment to the tests themselves” (Au, 2007, p. 263). Teachers base decisions about curricular choices in consideration of the high stakes assessments culture, and not solely on their professional judgement of what is educationally in students’ best interests (Au, 2007; Dennis, 2010; Vogler, 2008; Wills & Sandholtz, 2009). High-stakes assessments lead to the standardization of curriculum across LEA systems and emphasize traditional teacher centered teaching as a means to share information (Wills & Sandholtz, 2009). However, it has also been identified in a research study of Georgia teachers that, “educators and many advocates from the field of science have recognized the need for revising methods used for teaching science in schools in the United States in order to improve student performance on high-stakes testing” (Maxwell, Lambeth, & Cox, 2015, p. 2). This was clarified to include the need for students to gain knowledge and critical problem solving “as a result of the study of science through real-life problem-solving skills and understanding the world” (Maxwell et al., 2015, p. 3) in addition to increasing their achievement on yearly assessments. National science instruction guidelines for students include awareness with “concepts, theories, and models, an understanding of how knowledge is generated and justified, and an ability to use these understandings to engage in new inquiry” (Donovan & Bransford, 2005, p. 398). Educators have been called on to design curriculum that “serve diverse populations, promote inquiry, are based in research and learning and make extensive use of learning technologies” (Singer et al., 2000, p. 166). However, it has also been
noted that there is a “disconnect between the stated objectives of promoting inquiry and other district documents intended to support teacher implementation” (Meyer, Meyer, Nabb, Connell, & Avery, 2011, p. 59). The LEA guides the development of objectives and learning activities based on the standards, guidelines, and expectations provided by National and State departments of education. Therefore, differentiation of science implementation occurs between teachers in various LEA as “the roles that teachers play in elementary science classrooms to encourage science inquiry and to ensure learning are varied and influenced by local demands and situations” (Zhai & Aik-Ling, 2015, p. 910). In other words, learning activities, and “teaching actions will necessarily differ based on factors in the local environment, such as teacher knowledge, student age, student language proficiency, etc.” (Keys & Bryan, 2001, p. 632). Teachers could be termed the local expert in their classroom because they, “have an intimate knowledge of their own students; and because they are accountable for their students' learning and well-being in the classroom, only they can resolve all of the competing influences on what is enacted in the classroom” (Keys & Bryan, 2001, p. 637). One study of pre-service elementary teachers found that it was beneficial to “gather important information about their students’ diverse backgrounds that can affect their readiness to learn science” (Qablan & DeBaz, 2015, p. 11). Teachers then have a unique viewpoint and ability to design science curriculum. The relational ontology theory supports the development of autonomy; yet teachers have lost some of their independent autonomy to develop and design lesson plans as LEAs standardize curriculum (Thompson & Allen, 2012, p. 219). The consequence of high-stakes assessment on teaching has been a change in curricula development as well as a change in instructional practice to one centered on a teach to the test mentality “the widespread use of standardized testing at all grade levels and the specter of high-stakes testing for college admission continue to reinforce
traditional views of learning and teaching” (Windschitl, 2002, p. 135). Traditional teaching is described as a model in which the teachers are the source of shared knowledge via lecture and other instructional means (Taylor & Bilbrey, 2015). In learner centered activities, “students are viewed as active processors of information who have acquired concepts, skills, and attitude that affect their thinking about the content being taught” (Donovan & Bransford, 2005, p. 414).

Although, high-stakes assessment has promoted the use of traditional teaching methods, national science documents, “express the expectation that science teachers should be able to design classrooms where students take responsibility for their work” (Peters, 2010, p. 330). This philosophy is associated with a learner focused classroom structure. Therein, “the role of the student in a student-centered classroom is an active knowledge seeker” (Peters, 2010, p. 338).

Science inquiry is not associated with traditional teaching methods, “for the successful practice of scientific inquiry, the classroom needs to shift from one that is strongly directed by the teacher to one that is more student-directed” (Zhai & Aik-Ling, 2015, p. 908). This pedagogical shift is known as a student-centered approach to education in which “the student is encouraged to ask questions and be inquisitive and the academic is seen as a facilitator and guide, rather than as the main source of knowledge” (Seng, 2014, p. 143). Curriculum designed to allow students to engage in “extended inquiry also provides a mechanism to facilitate discourse” (Singer et al., 2000, p. 168), a process through which students construct knowledge collaboratively. In a study comparison of authentic inquiry and inquiry in schools based on textbook resources, it was stated that inquiry should also incorporate and build on the work of other scientists “the social construction of knowledge proceeds in ways that go beyond simple collaboration in groups” (Chinn & Malhotra, 2002, p.190). Thus, curriculum development should include opportunities for students to synthesize research and to learn how their inquiry
explorations connect with the work of scientists. Furthermore, curriculum which assists students to develop metacognition skills to become aware of and reflect on their personal inquiry process “could enable students to improve their learning expertise while also acquiring subject matter expertise” (White & Frederiksen, 1998, p. 4) Research identifies that, “teacher educators must be the change agents” (Ortlieb & Lu, 2011, p. 41) if teachers want to incorporate critical thinking skills and student centered learning to move beyond assessment focused instruction. Yet, the American educational system finds it difficult to move from traditional models of instruction to social constructivist models which include science inquiry and experimentation (Kazempour & Amirshokoohi, 2013; Nowicki et al., 2013; Taylor & Bilbrey, 2015). In the current age of educational accountability, teachers focus instructional time on the content areas for which they are accountable for test results and utilize traditional means to ensure content standards are covered in the classroom.

The curriculum hangs as a cloud over all thoughts of development because students must be prepared for their tests, and the teachers believe that this requires them to spend a substantial amount of time using their established approaches and the tasks found in text books that are similar to the tasks found in tests. (Goodchild, Fugelstad, & Jaworksi, 2013, p. 402)

Curriculum development in the age of educational accountability then is not primarily focused on the development and enrichment of thinking and learning in the content; rather it has been designed to produce test takers in the assessed content area.

Science Inclusion

The current educational system is at odds with the inclusion of and instruction in science content and applicable process skills as demonstrated by the research reviewed. In elementary grade levels, assessment is focused on ELA and math resulting in reduced “time for social
studies, science and other areas not tested by state or federal systems of test-based accountability” (Wills & Sandholtz, 2009, p. 1078). In research, it was stated that, “teachers believed that NCLB resulted in less science being taught in the elementary level” (Milner et al., 2012, p. 127). Pre-service teachers are beginning their careers with “strong perceptions of what it means to be a science teacher during an era when the results of high-stakes have a greater influence than ever before” (Shively & Yerrick, 2014, p.10). High-stakes assessment changes teachers’ views of instructional purpose and “science teachers believe it is their duty to cover all the science content outlined in textbooks to help students achieve high scores” (Abd-El-Khalick et al., 2004, p. 411). Although, elementary classrooms are responsible for teaching the four core areas of math, ELA, science, and social studies, “research suggests that science is virtually ignored in the elementary grades” (Cotabish et al., 2013, p.16). A study of science teachers’ beliefs discovered that “it was common for the elementary teachers to not teach science at all” (Lumpe, Czerniak, Haney, & Beltyukova, 2012, p. 163). Research into beliefs of elementary teachers in regards to the influence of required science testing on elementary classrooms found that “teachers reported linking science education to reading/writing/literacy/spelling in order to satisfy science requirements while focusing on the NCLB test” (Milner et al., 2012, p. 124). This was supported by another study in which one theme which emerged “from elementary teachers’ practices is that of integrating science with language education” (Keys & Bryan, 2001, p. 638). The research study addressed schools throughout the country but did not focus into a particular state and the beliefs and characteristics of teachers who elect to teach science using authentic science based strategies on a daily basis in the current educational culture focused on high-assessments. Although the educational environment has identified that science instruction has been limited in the elementary grade levels, paradoxically science has also been identified as one
of the key content areas for the careers of the future. The CCSS articulate college and career readiness as a goal of public education kindergarten through twelfth grade (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

In the global marketplace, students from America will compete with international peers for jobs in the future and assessment results are compared with worldwide student groups. Research found that, “low performance in science placed students in the United States at a disadvantage when competing with students from other nations” (Maxwell et al., 2015, p. 6). Thus, the educational conversation is further influenced by the growing interest in career preparation as “science education researchers joined forces with science, technology, engineering, and mathematics” (Capobianco, Yu, & French, 2015, p. 276) to state the importance of STEM for future career preparation. The interest lies in developing science knowledge and skills that translate into the careers anticipated in the future. Science educational reforms have touted inquiry as the method to reform and stated that inquiry “will continue to be a central factor in improving the status of science teaching and learning in American K-12 classrooms” (McLaughlin & McFadden, 2014, p. 92). Authentic inquiry allows “students to extend their everyday experiences of the world and help[s] them organize data in ways that provide new insights into phenomena” (Donovan & Bransford, 2005, p. 405). Despite the necessity for career preparation, inclusion of science content standards, and skills into the curriculum is limited in the elementary classroom in part due to the focus on preparation for high-stakes assessments to which LEA are mandated by state and the federal government. In the state of Missouri, time guidelines are not delineated for the number of minutes a week that teachers are to provide science instruction, LEAs are mandated to provide, “regular instruction” (Missouri Department of Elementary and Secondary Education, 2015, para. 2) in the content area. Therein, each LEA
and/or individual teacher determines the meaning of regularity and translates that to the amount of time daily or weekly which students receive instruction in science at the elementary grade levels. Thus, the amount of time spent learning science at the elementary level may vary significantly across the state of Missouri.

**Science Instruction**

Along with the articulation of the influence of assessment on curricular development and inclusion of science instruction, current literature reviewed defined science process skills and instruction. Process skills refer to skills necessary for students to complete learning and content tasks (Missouri Department of Elementary and Secondary Education, 2015). Science process skills include the ability to utilize scientific inquiry methods to solve authentic real-world problems, skills that are also recognized as college and career readiness traits (Ozedemir & Isik, 2015). Today and in the future problem-solving requires students to “learn how to creatively seek knowledge in order to make decisions about everyday situations” (Kim, Tan, & Talaue, 2013, p. 290). Instruction in science should utilize these process skills as part of the learning activities used in the classroom to teach and express science content knowledge. The National Council of Science identified in the Science Framework goals for kindergarten through twelfth grade science education. (National Research Council, 2012).

. . . all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussion on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including . . . careers in science, engineering and technology. (National Research Council, 2012, p. 10)
Science instruction is part of Science, Technology, Engineering, and Math (STEM) and a pathway to the career fields identified as the jobs of the future. The integrated intention of STEM and the inclusion of the Arts for STEAM coincides with the 21st century idea that “schools have a social responsibility to provide students with intellectually challenging experiences and opportunities to think creatively, innovatively, [and] collaboratively” (Bernhardt, 2015, p. 3). In a literature review of integration between ELA and science, it was found in the study that “where students outperformed similar peer groups taught using more traditional methods, language arts activities did not replace inquiry-based science teaching, rather they provided an important supplement” (Bradbury, 2014, p. 484). Additionally, in the review it was found that, “an integrated approach may provide the groundwork for positive attitudes and conceptual knowledge that can be built on throughout a school career” (Bradbury, 2014, p. 485).

STEAM learning and other “interdisciplinary instruction places equal emphasis on the mastery of both process and the mastery of content” (Ledoux & McHenry, 2004, p. 391). Therefore, integrated learning, whether STEM or STEAM initiatives, should support content and process skill knowledge attainment in each content area, included in these target skills are the ability to be reflective and metacognitive. When these skills are used in science it, “requires taking up the particular critical lens through which scientists’ view the world” (Donovan & Bransford, 2005, pp. 409-410). STEM learning activities provide opportunities for learners to “gain experience with 21st Century skills such as critical thinking, collaboration, and communication that will help prepare them to compete on the global level” (DeJarnette, 2012, p. 82).

Vygotsky’s (1978) theory of relational ontology discovered that through differing viewpoints and the utilization of social constructivist interaction teachers create opportunities for
learning which build student understanding. This is supported in current literature as, “researchers have recently increasingly emphasized that a person’s intelligent activity is based on interaction between physical and social environment” (Vedenpaa & Lonka, 2014, p. 1822). The physical environment and inquiry are areas that fall within the constructs of science content knowledge and learning processes, making it a relevant skillset for inclusion in the elementary curriculum which will impact student beliefs and knowledge. In this context, approaches to teaching science would “convince learners to change their science ideas within a context for social discourse” (Keys & Bryan, 2001, p. 640). This was reflected in the study’s findings which noted that “elementary teacher inquiry practices include establishing a collaborative community of scientists” (Keys & Bryan, 2001, p. 638).

Classroom practice and teacher beliefs are connected. Learning activities in the classroom have an impact on beliefs as, “research has also demonstrated that behavior changes before beliefs do” (Johnson, 2011, p. 52). Science instruction which allows students to interact and experiment in science will change student and teacher beliefs about science. The inclusion of science, in the elementary classroom, develops science knowledge which provides a, “context within which primary students experience cumulative meaningful learning in a fashion that enhances their capacity for comprehension” (Vitale & Romance, 2012, p. 460).

The majority of studies involving STEM and/or STEAM have focused on student learning at the high school level; “talent development models, suggest that talented high school students may have already developed a passion for a specific discipline” (Bruce-Dais et al., 2014, p. 275). Thus, this indicates that inclusion of science at the elementary level may increase a student’s passion for science. There is a lack of studies exploring STEM/STEAM at the elementary level in current literature. A lack was also noted by DeJarnette (2012), who identified
a need for research into how an innovative STEM learning “will spark motivation to pursue more advanced math and science courses and lay the foundation for STEM careers” (p. 82). The multi-disciplinary approach of STEM/STEAM discovered that “finding connections stretched their [students’] imaginations and stimulated the desire to think or read more about new knowledge domains” (McLaughlin & MacFadden, 2014, p. 942) identifying the process skills supported by STEM/STEAM. Research also connects constructivist approaches with science learning and the “need for students to demonstrate their knowledge by creativity, explanation and interpreting their work for others” (Chopra & Gupta, 2011, p. 8).

Current research has also noted that imagination plays a role in science and the, “importance of creative processes in the conduct of science can also be understood by exploring the types of reasoning and investigative choices that have made some scientific investigations particularly productive and feasible” (Donovan & Bransford, 2005, p. 406). Science instruction integrates innovation since “designing an experiment becomes a matter of creativity and ingenuity” (Chinn & Malhotra, 2002, p. 195). One study of metropolitan seventh grade students found that students who experience pre-designed labs, “are not directly exposed to the creative choices used in constructing knowledge about nature or how these choices affect the validity of their results” (Peters, 2010, p. 331). The constructivist approach includes authentic science skills, “in place of merely drill and practice and the memorization of facts” (Capps, Crawford, & Constas, 2012, p. 295). Instructional pedagogy based on constructivism refers to “how one attains, develops, and uses the cognitive processes that are involved in constructing knowledge” (Ledoux & McHenry, 2004, p. 387).

While the literature focused on secondary students is valuable and informative, more research is needed to determine if engaging students at earlier ages into the science content area
increases interest and achievement in the STEM discipline fields and ultimately in STEM careers. Research is also lacking on elementary teachers teaching STEM/STEAM in the classroom. It would also be of benefit for researchers to examine the characteristics and experiences of these teachers. Research conducted by Morrison (2013) examined exemplar teachers who had been enrolled in the graduate courses with the researcher and shared a similar understanding of inquiry through focus groups and a two-year study. Research into the characteristics of elementary teachers who represent the average or everyday teacher is a logical next step for current literature. Therein, a study that would naturally follow current research would examine the characteristics of everyday Missouri teachers who elect to incorporate science instruction on in a high-stakes assessment culture.

Current literature identifies that “elementary teachers are the gatekeepers to fostering the gifts and talents of future STEM innovators” (Cotabish et al., 2013, p. 216). Vygotsky (1978) stated that instruction occurs prior to the development of cognitive thinking in children. Time for science instruction then is a necessary precursor to student cognitive and critical thinking in the content area. A research study of elementary science teachers in Singapore noted that, “in an elementary science classroom, the teacher is often perceived to be the authoritative figure to provide the direction for learning” (Zhai & Aik-Ling, 2015, p. 907). In a study of science teachers from three countries, “one conclusion was that the first and possibly most influential factor affecting (prospective) teachers’ beliefs is the teacher themselves” (Siham, Silvija, Muhammet, Mehmet, & Ingo, 2014, p. 785). The science teacher is key then to developing science thinking skills. Another research identified concern is that, “interactional difficulties indicate that many science teachers are unprepared to effectively cope with the social demands of inquiry teaching” (Oliveira, 2010a, p. 248). A research study of pre-service teachers and inquiry
identified the propensity for teachers “to embody an understanding of teaching as transmitting knowledge from teacher to student through direct instruction rather than creating an environment where learners generate their own knowledge through exploration and investigation” (Villa & Baptiste, 2014, p. 25).

Thus, when considering the instruction of inquiry-based science into elementary classrooms, teacher beliefs about science, and teaching as well as the management of social interactions in the classroom may impact science instruction. It is further enunciated in current literature that, “elementary teachers often have both low confidence and high avoidance when it comes to teaching science in their classrooms” (Morrison, 2013, p. 574). A study with pre-service teachers found that in relation to science elementary instruction, “most teacher candidates were interested in pursuing instruction related to methods used in reading education” (Ortlieb & Lu, 2011, p. 46). In part, this may be attributed to the fact that, “it is extremely challenging for teachers to teach subject matter using an approach that they were not previously exposed to as students” (McLaughlin & McFadden, 2014, p. 928), or it may be attributed to a lack of content and process knowledge. In order for teachers to effectively assist students in making sense of the world around them, they must, “be knowledgeable about the nature of science. . . the powerful ideas of science – and the values beliefs and practices of the scientific community that guide the generation and evaluation of these powerful ideas” (Donovan & Bransford, 2005, p. 469). Teacher knowledge and understanding of the content must be at a level which allows them “to engage students in conversations that push their thinking about content and . . . [coordinates] ideas from multiple conversations to bring all learners to a robust understanding of science” (Windschitl, Thompson, & Braaten, 2008, p. 963).
The school setting becomes the center of a dichotomous relationship between science instruction and teachers of science. Highlighting the distance between the guidelines for science instruction and teacher knowledge and preparation in strategies for teaching the content. The case study on pre-service teachers noted that “reflection is an essential element in constructing understanding of a domain specific discipline, such as mathematics or science” (Villa & Baptiste, 2014, p. 31). Effective instruction which utilizes “self-reflection by teachers provides a feedback loop for goal modification” (Lumpe et al., 2012, p. 155). In other words, science instruction requires teachers to reflect on classroom practices in order to deepen their own content understanding and open pathways for students. Self-reflection and metacognition also allows teachers to identify their personal paradigms and beliefs about the content area. Research into the beliefs of kindergarten through sixth grade teachers, in urban and suburban Ohio, articulated that “teachers of science possess beliefs regarding their professional practice which may, in turn impact student learning” (Lumpe et al., 2012, p. 155). Educators who engaged in professional learning about science instruction and inquiry “displayed significant gains in their science teaching self-efficacy” (Lumpe et al., 2012, p. 162). Teacher beliefs and self-efficacy may impact science instruction. Teacher belief research suggests “a strong relationship between beliefs and classroom practice” (Milner et al., 2012, p. 113). A research study of elementary pre-service teachers conducted by Biggers and Forbes (2012), concluded that “science teacher educators must first elicit their ideas about inquiry-based teaching and learning and then draw upon those ideas to inform the design of science methods course components” (p. 2206). Teachers’ beliefs about education, learning and science “may impact their actions. . . [they] play a critical role in . . . restructuring science education” (Milner et al., 2012, p. 114). Therefore, educators of science open possibilities in the classroom.
Authentic science instruction in the classroom includes when, “the teachers create opportunities for their students to learn inquiry skills and to reflect on inquiry” (Capp, et al., 2012, p. 294). Elementary students described individuals who are science people as people with an interest in science and who are also good at science (Archer et al., 2010). However, it was also noted that children claim, “anyone can do science if they want” (Archer et al., 2010, p. 631) which can be articulated as a growth mindset philosophy. Students with a growth mindset perceive teachers to be people from whom they can learn (Dweck, 2006). The development of student interest in science is one of the keys to future career development (Hall, Dickerson, Batts, Kauffman, & Bosse, 2011, p. 235). Current literature reports that “children wanting to enter the discursive science community may be influenced by the degree to which they are already interested in science and their existing identity structures” (Girod & Twyman, 2009, p. 14). Thereby, providing opportunities for students to experience real-world science activities influences future interest in science fields and careers. In other words, “the effectiveness of science inquiry teaching has been emphasized to enhance children’s critical thinking and problem solving in the present and future society” (Yoon, Joung, & Kim, 212, p. 604). Research also described that students are more resilient in learning and can build their understanding of cognitive development and intellectual ability “when they encounter the rigorous learning opportunities presented to them” (Yeager & Dweck, 2012, p. 306). Students can enjoy learning science without developing an interest in a science career (Archer et al., 2010). Yet, research describes the value of science inclusion at the elementary level and the connection between the inclusion of science instruction and the development of student interest in the content area and the potential to motivate students toward career fields in the content. In a study of integrated learning with second grade students it was remarked that, “the diminishing prevalence of
science-specific instruction in U.S. elementary classrooms, exacerbated by the assessment-driven pressures of our current accountability systems, threatens to leave us with a generation of science-illiterate children” (Girod & Twyman, 2009, p. 14). In a three-year study of urban science teachers, the connection between literacy and science integration was described, “there is a process that you can go through to find answers to your question, and it’s a research process, and I see that as a scientific as well as literacy process” (Howes, Lim, & Campos, 2009, p. 202). Science and literacy integration must be purposeful and “if texts are to play a richer role in inquiry-based science teaching, they need to be a part of the inquiry and not the end point” (Howes et al., 2009, p. 210). Elementary teachers play a role in the development of student science knowledge attainment that potentially impacts future careers.

**Scientific Inquiry**

*Inquiry.* The scientific method and inquiry are a part of the experimentation process within science instruction. Inquiry has long been touted as “the central word used to characterize good science teaching and learning” (Anderson, 2002, p. 1). Inquiry is a social constructivist process which “develops as interplay between known and unknown in situations where some individual or group of individuals is faced with a challenge” (Artigue & Blomhoj, 2013, pp. 798-799). Research found that overall students “seemed motivated in the exploration process” (Wolf & Fraser, 2008, p. 324). Inquiry as a means of exploration enables students to engage higher cognitive functions which must be achieved socially as they do not develop naturally as a progression of child maturation (Kirch, 2014; Marshall & Horton, 2011). Therein, collaborative or social interaction activities such as inquiry promote the development of student cognitive skills and construction of knowledge. Achieving through social interaction is a tenet of relational ontology theory (Vygotsky, 1978). Research also found that, “forms of knowledge about inquiry
which are viable in classroom practice will become constructed forms of inquiry” (Keys & Bryan, 2001, p. 633). Inquiry based learning (IBL) is a teaching strategy which, when described in research, reflects the same skills as scientific inquiry.

In the ideal IBL classroom, students are active participants. They observe and formulate questions; if problems are too complex, they simplify or model; they make reasoned assumptions, collect and analyze data, make representations, and make connections with what they already know. They interpret findings, check that they are sensible and share them with others. (Swan, Pead, Doorman, & Mooldijk, 2013, p. 945)

However, the interpretive nature of the definition of inquiry “leaves much of the decisions of how to teach up to the individual teacher” (Biggers & Forbes, 2012, p. 2208). Therein, “to teach science as inquiry, teachers must possess adequate subject matter knowledge and pedagogical expertise” (Kang, Bianchini, & Kelly, 2013, p. 433). Inquiry benefits students not only through experimentation and motivation to learn, but research has also found that students who received science instruction through inquiry methods had higher achievement and developed deeper content knowledge. (Archer et al., 2010; Wolf & Fraser, 2008). This was supported in a research study of fifth grade students in Taiwan which postulated that guided inquiry activities in the classroom assisted students in having “a richer understanding about the nature of scientific questions” (Wu & Wu, 2011, p. 337). One barrier identified in research to the implementation of inquiry based learning (IBL) at the elementary level is teacher professional learning and content knowledge (Furtado, 2010; Kazempour & Amirshokoohi, 2013; Morrison, 2013; Morrison, 2014; Nadelson et al., 2013; Nowicki et al., 2013). Current research identifies that “to foster inquiry-based science learning environments, then, PTs [Pre-service Teachers] must first develop robust conceptual frameworks for what constitutes inquiry (Biggers & Forbes, 2012, p. 2207).
The study also concluded that “allowing for more teacher-directed forms of inquiry opens possibilities for novice elementary teachers to explore inquiry in their classrooms” (Biggers & Forbes, 2012, p. 2223). Another study examined teacher’s professional learning experiences with IBL in an authentic environment conducting paleontological fieldwork finding that inquiry experiences contribute to a teacher’s ability to implement IBL with students (McLaughlin & McFadden, 2014). Thus, experiential learning with science inquiry increases a teacher’s ability to design lessons and provide IBL instruction in the classroom.

**Science pedagogy.** Pedagogy is a word which means, “leading a person to knowledge” (Gutek, 2011, p. 458). Research focused on science instruction describes the pedagogy or the thinking behind how to teach the content area. “Science is broadly construed to mean the investigation of the various subject-matter disciplines, not in isolation from each other but in terms of what they could provide to solve problems” (Gutek, 2011, p. 363). This may also be termed as integration of content area knowledge. Inclusion of various subject matter is at the root of STEM/STEAM pedagogy which encourages students to integrate the knowledge and skills from each of the disciplines to solve problems. A review of current literature identifies that both STEM and STEAM initiatives utilize inquiry-based learning as a foundational instructional strategy; “inquiry science pedagogy provides an ideal framework for helping students develop strong skills in problem solving and critical reasoning while simultaneously acquiring a broad knowledge of science content” (Nowicki et al., 2013, p. 1136). Inquiry learning also has benefits to other content areas and “increasingly, the effect of scientific inquiry instruction on achievement, as well as other educationally relevant outcomes explored by researchers is of great interest to policy makers around the world” (Minner et al., 2010, p. 475). Science pedagogy includes helping students to think and act like scientists and engineers through inquiry and
experimentation in the classroom (National Research Council, 2012). Additionally, inquiry allows students to use “cultural tools for[sic] like microscopes, computers and probeware to mediate their learning, speak [sic], thinking and acting” (Shively & Yerrick, 2014, p. 2). Research describes inquiry at the highest level as being able to “bring unobservable evidence to the fore, enable abstraction and analysis, and engage students in the active co-construction of scientific knowledge and interpretation” (Shively & Yerrick, 2014, p. 2). Therein, teacher science pedagogy is a cornerstone to the instructional strategies implemented in the classroom and assists students to develop critical thinking skills. In order to implement science inquiry in the classroom, “teachers need to develop those pedagogical skills necessary to effectively teach about inquiry” (Abd-El-Khalick et al., 2004, p. 404). Within any curriculum design there are pedagogical conflicts to overcome and address these are not inherently any greater for science inquiry than other content areas. (Meyer et al., 2011). Pine et al. (2006) raised the question “to what extent student interest in science learning and careers decline due to a focus on assessment and fewer hands-on experiences” (p. 482). Moreover, in research it was also identified that “students’ motivation and learning about science are mostly related to a teacher’s teaching method and not to science content itself” (Kim, 2016, p. 183). Thus, the teacher is one of the key factors influencing on student science learning since he or she controls the methods of instruction. Crawford (2007) presented “an argument for the importance of researchers examining teachers’ knowledge and beliefs in the rough and tumble of practice” (p. 637). Thus, identification of the beliefs and characteristics of science teachers would add to the relevant understanding of current science pedagogy.

Scientific inquiry. Relevant to career and college readiness skills are the abilities to utilize scientific inquiry methods to address learning as a process of reflection, thinking and
utilizing inquiry to experiment and solve real-world problems. Science inquiry applies knowledge to real-world problems to help students understand the outside world through encouragement to use inquiry and to accept those answers that are supported by evidence (Bruce-Dais et al., 2014; Engeln et al., 2013; Mangiante, 2013). Teachers can elect to employ many science instructional strategies beyond inquiry. However, scientific inquiry “is important because inquiry instruction exposes students to a type of learning that parallels the work of practicing scientists” (Capps & Crawford, 2013, p. 500). Science inquiry and constructivism are rooted in the philosophy that learning is an adaptive process through which the learner experiences the world. Social interaction as described in Vygotsky’s (1978) social learning theory articulates that “children are capable of doing much more in collective activity. . .” (p. 88). Collective activity or social learning is comprised of “man’s capacity to learn by observation. . .” (Bandura, 1971, p. 2). In other words, “psychological functioning involves a continuous reciprocal interaction between behavior and its controlling conditions” (Bandura, 1971, p. 39). Students then can learn by observing and interacting with other students and sharing learning experiences. Student interactions with one another through scientific inquiry “can be defined loosely as a way of teaching in which students are invited to work in ways similar to how mathematicians and scientist work” (Artigue & Blomhoj, 2013, p. 797). Inquiry instruction is a methodology that also teaches the processes of science: “making observations, putting questions for research, planning investigations, comparing existing knowledge with experimental results, comprehending the results, collecting evidence and using proper means and methods for analysis and interpretation, proposing and communicating answers, explanations and expectations” (Ozdemir & Isik, 2015, p. 44). Yet, teacher practitioners have different conceptions of inquiry as it relates to learning and classroom instruction. Even though current research shows that IBL is important in science
instruction, “teachers continue to struggle with what inquiry should look like and how it should be taught” (Gillies & Nichols, 2015, p. 174). For some teachers, this conception is the adoption of “a cognitive functional perspective on oral questioning, viewing teacher questions essentially as communicative devices for promoting higher-level scientific thinking among students” (Oliveira, 2010b, p. 424). Strategically designed questions which are rooted in content knowledge and purposefully crafted will lead to deeper understanding through social interaction is scientific inquiry (Blanton, Westbrook, & Carter, 2005; Oliveira, 2010b). Research has also identified that, “despite participation in numerous PD activities, many science teachers continue to hold misconceptions about inquiry that influence the way they design and enact instruction” (McLaughlin & MacFadden, 2014, p. 931). Even teachers who understand inquiry may continue to struggle with how to design IBL activities for the classroom (Meyer et al., 2011). In other words, “teaching inquiry methods can be a daunting and elusive task for many teacher educators” (Villa & Baptiste, 2014, p. 25). One reason might be the determination whether the teacher should guide inquiry or if it should be completely student-centered; pre-service teachers “believed that structured guided inquiry would be necessary for knowledge acquisition” (Yoon, Joung, & Kim, 2012, p. 601). Current research literature defines the need for teachers to have professional learning in inquiry in order for the instructional strategy of inquiry, whether open or guided to be implemented in the classroom (Furtado, 2010; Kazempour & Amirshokoohi, 2013; Morrison, 2014; Nadelson et al., 2013; Nowicki et al., 2013). Furthermore, professional learning should be strategically considered and planned, “it would be important to provide teachers adequate time to discuss questions and concerns they might have, as well as their experiences in the classroom” (Capps et al., 2012, p. 300). A study of pre-service teachers found that practical classroom tools and strategies enabled teachers to “guide their students in inquiry science
learning and foster their beliefs and understanding on how to use inquiry” (Qablan & DeBaz, 2015, p. 16). Literature reviewed also identified that “teacher motivation and beliefs are key in changing instructional practices” (Johnson, 2009, p. 302). Therein, further research into the beliefs and characteristics of elementary teachers utilizing inquiry in the classroom on a daily basis is needed.

**Inquiry application.** Although there are many studies focused on inquiry, one of the clearly identified needs in the literature is for a specific definition of inquiry as it pertains to science instruction; scientific inquiry, problem based learning, inquiry based learning (IBL), and experiential science learning are a few of the associated instructional terms and strategies (Furtak, Seidel, Iverson, & Briggs, 2012; Marshall & Horton, 2011; Minner et al., 2010; Ortlieb & Lu, 2011). Consequently, the first challenge to examining the inclusion of science and application of inquiry in the elementary classroom in a non-assessed content area requires a clear definition of science inquiry instruction. A clear notion is difficult to obtain and “the ubiquitousness [sic] of inquiry nonetheless, extends far beyond the local of the United States” (Abd-El-Khalick et al., 2004, p. 399). Therefore, the definition of inquiry in the classroom is an international challenge. Therefore, authentic science instruction is being defined as an inquiry based pedagogy in the elementary classrooms. Science teaching which is grounded in inquiry “demands a set of teaching practices that are quite different from typical didactic science instruction” (Qablan & DeBaz, 2015, p. 10). This method of teaching can be described as “the traditional ‘chalk and talk’ didactic methods of instruction” (Ireland, Watters, Brownlee, & Lupton, 2014, p. 1739). The following definitions represent a synthesized understanding of science inquiry based on current literature. Inquiry based learning (IBL) promotes higher order thinking through active engagement of students cognitively with peers through intellectual
conversation and metacognitive thinking. Inquiry instruction then is equated with hands on learning through collaborative discussion and argumentation to deductively answer open-ended questions and find solutions to relevant problem-solving that challenge students’ thinking and metacognition (Areepattamannil, 2012; Bruce-Dais et al., 2014; Engeln et al., 2013; Furtak et al., 2012; Goodchild et al., 2013; National Science Teachers Association, 2014a). It can also be said that “students use scientific process skills during inquiry” (Simsek & Kapabinar, 2010, p. 1193).

Throughout the metacognition and reflection process, students should engage in collaboration “so that students may see how multiple perspectives can be applied in viewing one’s own and others’ work as they carry out the process of inquiry and modeling” (White & Frederiksen, 1998, p. 9) The application of inquiry which is constructivism, “encourages students to use their prior knowledge for better understanding of theories and concepts” (Chopra & Gupta, 2011, p. 11).

The application of inquiry learning “is an active mental process that demands the active participation of the learner” (Anderson, 2002, p. 2). Inclusion of authentic inquiry activities benefits learners since it requires complex thinking and analysis of data for “all citizens need to be able to reason well about complex evidence” (Chinn & Malhotra, 2002, p. 213). Implementation of inquiry “requires students to understand how to go about learning actively and engaging in a scholarly manner” (Peters, 2010, p. 343). The study of fifth grade science students in Georgia supported that, “IBL instruction results in greater engagement of students during science” (Maxwell et al., 2015, p. 25). In a study of IBL and technology, it was found that “hands-on activities improved both boys’ and girls’ attitudes about science” (Kim, 2016, p. 176). In a study of pre-service teachers, one concern about implementing inquiry was the ability to “adapt instruction to their students’ abilities and understandings” (Kang et al., 2013, pp. 444-445). Current literature identified that “students across the full range of socioeconomic levels performed at about the
same average level on the inquiry tasks” (Pine et al., 2006, p. 481). A study of professional development and student achievement with middle school students found that inquiry-based instruction increased science achievement on science assessments for Caucasian, African-American, and Hispanic subgroups (Marshall & Alston, 2014) While another research study conducted in Turkey examined student learning when taught using IBL “provided empirical evidence. . . by producing research data that shows IBL improved students’ conceptual understanding” (Simsek & Kapabinar, 2010, p. 1193). Furthermore, a study of how inquiry science motivates eighth grade students of diverse learning styles concluded that “inquiry lessons can increase students learning motivation” (Tuan, Chin, Tsai, & Cheng, 2005, p. 559). The study further articulated that inquiry instruction provides students of all learning styles challenging tasks which promote their motivation to learn science (Tuan et al., 2005, p. 563). Additionally, a comparison study of traditional teaching and inquiry approaches identified an effect size that “indicate[s] the benefit of using the inquiry-oriented approaches” (Akkus, Gunel, & Hand, 2007, p. 1762). Therefore, inquiry application in the classroom increases student engagement in learning, increasing academic achievement as well as the development of critical thinking skills and concept knowledge for all students.

**Science benefits.** In addition to the articulation of science processes and instruction terms, recent studies have also identified benefits to students through the engagement in higher cognitive functions designed to extend student thinking and apply knowledge to solve complex problems (Marshall & Horton, 2011). Inquiry in the classroom provides “students with opportunities to be critical and skeptical to compare existing knowledge with observed events” (Ozdemir & Isik, 2015, p. 44). Thus, a benefit of science instruction is the development of student skills and abilities which enable them to critically examine problems while utilizing data
and observations. In the search for solutions to problems, “scientific knowledge could be applied to all the activities that human beings need[ed] to perform” (Gutek, 2011, p. 319). Science can also “improve people’s lives in fundamental ways” (National Research Council, 2012, p. 7). Added to the benefit of science inquiry is the connection to multiple contents and developing intellectually. The theory of relational ontology as a foundation of inquiry articulates a link between an individual’s interactions with the social and physical environment and the development of intelligence (Vedenpaa & Lonka, 2014). Collaborative learning groups challenge each other’s thinking as students work together to explore and build knowledge which is a benefit of interchange that comes about as a result of the inquiry process (Artigue & Blomhoj, 2013, pp. 798-799). In part, this may be due to the modeling of diverse behaviors, and “it is diversity in modeling that fosters behavioral innovation” (Bandura, 1971, p. 11). Also, inquiry includes opportunities for students to work as a team challenging and learning from one another’s strengths and knowledge. In the study of middle school girls when technology and IBL were examined, one result supports the “notion that in order for female students to explore and consider science as a career, they need to identify with scientists and envision the possibility of themselves as scientist” (Kim, 2016, p. 182). Another study found that inclusion of inquiry and metacognitive process in science education benefits low-achieving students with these students, “as likely to independently show their mastery of the concepts” (White & Frederiksen, 1998, p. 38) as their high-level peers. Therein, a benefit of IBL and science inclusion in the classroom is to bring a vision to subgroups of students which allows them to see themselves as scientists. Another benefit which was defined in a study of inquiry with pre-school students identified that purposeful science scaffolding learning when supported with teacher interactions is, “commensurate with Vygotsky’s (1978) zone of proximal development” (McLean, Jones, &
This means students are engaged in learning at the level that best allows them to be successful. Current literature also reports that “children’s natural curiosity to investigate and explore needs to be nurtured in the classroom” (Maxwell et al., 2015, p. 7). Inquiry then benefits students by building their academic curiosity. Another study centered on designing inquiry activities found that while students might struggle and never finish a significant inquiry activity, “a meaningful experience cannot arise if students cannot relate to the task at all” (Meyer et al., 2011, p. 61). Thus, purposeful implementation of science designed within a students’ ZPD to incorporate and scaffold learning when students are ready and able to access the learning will benefit student learning outcomes.

**Science skills.** Current research reviewed addressed the need to, “develop student science understanding” (Vitale & Romance, 2012, p. 458). Current literature also found that traditional teacher discourse in science classrooms “do[es] not encourage or even allow, the type of discourse that scientists undertake” (Akkus et al., 2007, p. 1748). Science discourse skills and the inclusion of inquiry in the learning environment requires different skills than the traditional classroom; it “implies a shift from traditional, mainly deductive, teaching styles towards more appealing and activating forms of teaching and learning” (Engeln et al., 2013, p. 823). Science skills in literature are not associated with traditional teaching defined as a classroom in which the teacher is the giver of knowledge (Taylor & Bilbrey, 2015). In the study of exemplar teachers, Morrison (2013) identified that prior to moving toward inquiry, teachers “need to recognize a problem with the traditional way of teaching before they will change to more inquiry-based practices” (p. 580). However, Chinn and Malhotra (2002) noted that inquiry tasks need to “come closer to the epistemology and reasoning processes of authentic science” (p. 176). This includes implementation to “provide students with feedback, encourage students to evaluate themselves
and draw connections, help pupils articulate their thoughts and opinions” (Oliveira, 2010b, p. 266) as well as considering how their verbal and nonverbal reactions impact science learning. Furthermore, it requires teachers to develop a fundamental “understanding of science as inquiry and learning as inquiry” (Anderson, 2002, p. 8). Teaching to the test is identified in current literature as a move to the inclusion of traditional teaching methods including lecture and teacher-direct instruction (Isikoglu et al., 2009; Windschitl, 2002). The American education system finds it difficult to move from traditional models of instruction to constructivist approaches such as science inquiry (Nowicki et al., 2013; Taylor & Bilbrey, 2015). It was postulated in a study of inquiry supported by research that teachers of the future will not have the educational experiences as learners to enable them to teach science with inquiry even when it is supported by technology (Shively & Yerrick, 2014). This was based on the pre-service teachers in the study admitting that they had “not witnessed inquiry tools in their K-16 learning experiences” (Shively & Yerrick, 2014, p. 8). Another study of elementary pre-service teachers in Korea framed teacher experiences with inquiry in this light, “it is critical to provide some authentic inquiry experiences to pre-service teachers” (Yoon et al., 2012, p. 590) This brings up the question of how teachers can teach science skills they have never learned especially in an educational culture shaped by federal and state assessment expectations. Further, how are in-service teachers who implement authentic inquiry science similar? The conflict between assessment and science skills is one which research noted that “teacher candidates learn these struggles early in their education program” (Ortlieb & Lu, 2011, p. 41). In current research it was found that “teachers’ beliefs were more influenced by their administration and peer group than they were by federally mandated policy” (Milner et al., 2012, p. 127). Indeed, even though inquiry inclusion is supported in “every national science teaching curriculum, inquiry is not
widely implemented in the classroom” (Peters, 2010, p. 346). The question is raised not only as to “whether teachers are willing and able to implement an inquiry-based curriculum” (Abd-El-Khalick et al., 2004, p. 411), but also what local barriers stand must be considered. A study of middle school and high school teachers indicated that “the removal of barriers by school districts/school administration” (Herrington, Bancroft, Edwards, & Schairer, 2016, p. 201) had a role in changing teachers instructional practices. Educators must be supported and made to feel that “elementary science is important and it must ‘count’ in the minds of school administrators” (Milner et al., 2012, p. 129). In part, this may require “transforming teacher beliefs [which] is fundamental to enduringly transforming their understanding and practice of inquiry in their classroom” (Herrington et al., 2016, p. 184). Current literature also expresses the idea that “knowledge and beliefs about teaching are entangled” (Crawford, 2007, p. 616). One study of professional development in inquiry completed with high school teachers noted that a “lack of change in participants’ beliefs may be attributed to the stable nature of beliefs” (Luft, 2001, p. 530). Although educator beliefs did not change significantly in the study, the participants’ implementation of IBL activities in the classroom did increase (Luft, 2001). Educator beliefs of educational pedagogy, science instruction, context, and inquiry may vary by individual due to personal experiences, emotions and backgrounds, yet they are key to understanding science instruction and skills taught in the classroom. “Context beliefs deal with teacher perceptions of how the environment will respond to and support effective science teaching” (Johnson, 2009, p. 289), meaning that the school culture and environment may also affect the science skills incorporated into the classroom. Current research identifies that “changing instructional practices is a feat not accomplished easily or without conflict, whether the conflict is internal or external” (Johnson, 2009, p. 290). Research into six approaches of inquiry used by elementary teachers
speculated that on challenge “teachers must first embrace is in learning to see scientific knowledge as created, not discovered or revealed” (Ireland et al., 2014, p. 1748). Thereby, if educational LEAs are to move toward inquiry-based science instruction and science inclusion in the elementary classrooms to develop science skills, then teachers must identify a need for the change and a vision of how the method may accomplish the goal of developing scientific content knowledge and process skills in students as well as meeting state and federal regulations. Additionally, it is necessary for research into teacher beliefs since, “a teacher’s beliefs about how students learn can profoundly affect his or her design of instruction” (Crawford, 2007, p. 617). A research study of fifth grade students in which inquiry and textbook learning expressed the belief that “student performance reflects a combination of the curriculum itself and the way it is being implemented by the teachers” (Pine et al., 2006, pp. 480-481). The development of authentic science inquiry skills promotes college and career preparedness as well as providing students with the skills to solve scientific problems.

Areas in Need of Further Research

Review of the current literature reveals four areas for additional study and research. First, the examination of science elementary instruction in a high stakes educational culture which also places importance on STEM/STEAM learning is needed. Defining the impact of science instruction at the elementary level on the future career goals of students who experience science inquiry instruction would be a component of understanding how elementary instruction affects the development of interest in pursuing STEM careers.

Second, research is needed into the level of content and process knowledge needed by elementary teachers and the professional learning required to obtain the needed content and process knowledge to effectively implement authentic science learning in the classroom.
research articulated professional learning as an obstacle to implementation of inquiry-based science instruction in the elementary classroom. Research articulates the value of the teacher in the classroom, “teachers of science courses are instrumental in implementing the science curriculum at schools” (Ozdemir & Isik, 2015, p. 45). It was further found that “transforming teacher beliefs is fundamental to endurably transforming their understanding and practice of inquiry in their classroom” (Herrington et al., 2016, p. 184). Research to identify professional learning in inquiry for teachers of all experience levels would address the articulated obstacle to the inclusion of science at the elementary level.

Third, the experiences of teachers who elect to incorporate inquiry instruction in science into the classroom have not been expressed; “teacher development must precede student development” (Kirch, 2014, p. 245). Therefore, the mindset and experiences of the teachers should be understood to provide current research for teachers to utilize when strategically planning curriculum. The purpose of a phenomenological study to discover “a central meaning and unity that enables one to understand the substance and essences of the experience” (Moustakas, 1994, p. 9). Examining the experiences of participants who implement science in a grade level which is not accountable to the content would add to the body of knowledge as “phenomena are the building blocks of human science and the basis for all knowledge” (Moustakas, 1994, p. 27). Provision of the discovery of characteristics and strategies for teachers experiencing the phenomenon will increase the body of teacher knowledge, which must occur before changes take place in the classroom. One study did examine inquiry-based STEM preparation and perceptions in elementary students; however, the data was not triangulated and reflected teachers from only one setting bringing into question how the sample might represent the total population (Nadelson et al., 2013). Another study examined the characteristics of
exemplar science teachers in which the six teachers involved noted “that [if] they had one
description that would fit them all as children [it] was that they were inquisitive” (Morrison,
2013, p. 578). A research study of teachers of fifth through ninth grade was also conducted to
identify inquiry in the classroom; in this study, teachers of all abilities were included finding that
inquiry inclusion in the classroom was not consistent (Capps & Crawford, 2013). In the study, it
was uncovered that teachers without particular science ability implemented inquiry through
“having their students collect or manipulate data” (Capps & Crawford, 2013, p. 514). It was also
found in the study of the 26 teachers that “in the majority of the classrooms, there was little or no
evidence of abilities or features of inquiry” (Capps & Crawford, 2013, p. 515). However, the
study did not include elementary teachers in grade levels which were not assessed in the content,
who were not considered to be exemplar science teachers in order to articulate the
characteristics, beliefs, and experiences of the standard or average elementary teacher who elects
to include science instruction on a daily basis. Hattie’s (2012) meta- analysis of instructional
strategies effectiveness found teachers to be one of the most influential factors in learning.
Thereby, the teacher in the front of the room becomes a valuable resource to student learning of
content knowledge and 21st Century Skills; “it is only natural to focus on critical thinking skills;
teacher educators must be the change agents if success is attainable” (Ortlieb & Lu, 2011, p. 41).
Future research was suggested into the “time of implementation along the school year” (Oliveira,
2010b, p. 448) rather than a solitary observation. The election to study the daily implementation
of science will articulate the essence of teachers who teach science daily at the elementary levels.
Therefore, the characteristics and mindset of elementary teachers who implement science content
in grade levels which are not accountable to state assessment, along with his or her perceptions
which impact curricular planning in the elementary classroom in a high-stakes assessment
culture have not been clarified through research studies and would fill the gap in the current literature.

Fourth, is the examination of the experiences of teachers who craft instruction and curriculum to include both outcomes including accountability for assessment in content areas as well as the development of science content and process skills. Research is needed to answer the question how much time at the elementary level is spent in learning in the disciplines that are not assessed. Teachers must work with students to meet the accountability expectations of the LEA, state and or federal government. Therefore, educator concerns around accountability stem from legislation, evaluation practices, and both perceived and realistic consequences of failing to meet accountability standards. One study examined how two urban, New York teachers instructionally planned for science while considering preparing students for the state assessment and how that might be impacted by inclusion of specific assessment tasks (Mangiante, 2013). While the study considered the influence of state assessment on classroom instructional planning, it did not articulate the characteristics of the teachers. Therefore, identifying teacher characteristics which promote balance in planning to incorporate science in the elementary classroom as well as to make time in the instructional day for developing an interest in the STEM or STEAM content learning for students needs to be researched. An additional study examined middle school students, yet there is a lack of studies involving the inclusion of science in grade levels not assessed in the content in the high stakes educational culture. Teacher-centered instruction is associated with high stakes assessment while student-centered inquiry instruction is connected to a “constructivist learning approach includ[ing] cooperative learning; discussions, problem-solving activities, and inquiry and ‘hands on’ learning and guided discovery” (Vogler, 2008, pp. 12-13). Current research identifies that “inquiry strategies are student centered, with students
answering scientific questions through investigation” (Johnson, Zhang, & Kahle, 2012, p.2).

Thus, scientific inquiry is considered a constructivist and student-centered approach to learning and provided as a counterpoint to assessment preparation in the elementary classroom. Examination of the topic would add to educational practice.

**Summary**

The goal of education in American society is to educate all students and prepare them for college and careers (No Child Left Behind Act of 2001, Pub. L. 107-110, 115 Stat. 1425). In an effort to accomplish this goal, legislation, standards and instructional strategies, and initiatives are implemented to close achievement gaps, while holding educators accountable for the academic growth of all students and to ultimately prepare students to be college and/or career ready. 21st Century learning skills and the jobs of the future have been identified as those that utilize creativity and innovation and are set primarily in the STEM career fields. Growth Mindset Theory reminds teachers that students are the educator’s legacy and as such a growth mindset “has a key role to play in helping us fulfill our mission and in helping them fulfill their potential” (Dweck, 2006, p. 211). Science instruction is a content area that when integrated in the classroom through active inquiry methods is purported to spur student interest in the content and assist students in the development of knowledge and processes which will serve them in the career fields of the 21st Century. Social interactions in the classroom with peers, “and particularly with adults are the vehicle for exposure to science concepts in instruction” (Fox & Rionscente, 2008, p. 384). The reviewed literature focused on specific LEAs STEM intervention; however, the implications and experiences of teachers who implement science instruction daily as an individual choice, whether that is science content standards or STEM/STEAM learning, was not illuminated. Inclusion of science at the elementary level may increase student interest which will
eventually translate into increased participation in STEM career fields across all demographics. Future examination is needed to uncover the characteristics of teachers who choose to implement an authentic inquiry science curriculum in an elementary grade level which is not accountable through state assessment for the content area. The strategies of the teachers who implement science instruction but who feel limited by external factors will be revealed and add to the body of instructional knowledge.
CHAPTER THREE: METHODS

Overview

The purpose of this phenomenological study was to discover the shared experiences of teachers who implement science in elementary classrooms that are not assessed by state assessments. The Growth Mindset Theory and Social Constructivist Theory guided questions and analysis. While the theory of relational ontology informed the review of teacher characteristics as they occurred within the Local Education Agency (LEA) or autonomously to make the curricular decision to include science inquiry instruction in the elementary classroom. The procedures utilized followed the transcendental phenomenology approach to discover the essence of the experiences of the teachers serving as participants.

Design

A qualitative method was appropriate for this study because it sought to understand and “describe the common meaning for several individuals of their lived experiences” (Creswell, 2013, p. 76). This study examined the experiences of elementary teachers who despite a culture focused on high-stakes assessments in the classroom have made the decision for their students to incorporate content areas and strategies in the non-assessed science content.

A phenomenological study was appropriate to “focus on exploring how human beings make sense of experience and transform experience into consciousness” (Patton, 2002, p. 104). I sought to identify a specific type of teacher to illuminate the characteristics or strategies employed by education practitioners to develop an inquiry-based science instructional program in science and to recount their experiences. The transcendental approach was utilized as I took a “fresh perspective” (Creswell, 2013, p. 80), in the examination of the concept. A fresh approach to examine the experiences of Missouri elementary teachers was appropriate to analyze their
shared experiences. The high-stakes assessment culture has been examined from the view of content areas that are assessed. However, the perspective of teachers choosing to teach a non-assessed content had not been revealed. The transcendental approach was appropriate for the study as uncovering the participants’ experiences was the focus of the study (Creswell, 2013, p. 80). A transcendental approach “adheres to what can be discovered through reflection on subjective acts and their objective correlates” (Moustakas, 1994, p. 45). In other words, a transcendental approach uncovers and describes the reality of the phenomenon through the observations, artifacts and documentation of the participants involved with the phenomenon.

**Research Questions**

**Central Question**

CQ: What are the experiences of elementary teachers in Missouri who chose to include instruction using authentic inquiry-based science content instruction in an educational culture centered on assessment in math and ELA?

**Sub-questions**

SQ1: What are the beliefs of Missouri teachers choosing to teach science in non-assessed grades?

SQ2: What are the strategies teachers take to provide authentic science instructional format to teach Missouri Learning Standards?

SQ3: What are the characteristics of teachers who do not only *teach to the test*, as evidenced by teaching science in a non-assessed grade?

**Setting**

The sites included are third and fourth grade elementary classrooms located within Missouri Public Schools. Inquiry was made into the need for permission to conduct research
within the state of Missouri (Appendix A). The physical locations of the LEA sites were in the state of Missouri. Participant schools were sought around the state and were not centered in any one specific geographic location. The decision to select sites in the same state was determined by the anticipated consistency within the public-school system in regards to teacher accountability to the same set of learning standards, teaching indicators, and assessments, ensuring teachers share in the phenomenon. The schools within in the state are accountable to the Missouri Learning Standards (MLS) or Grade Level Expectations (GLEs) for science, curriculum terms that are used interchangeably in the state. There is no weekly or daily time requirement for science instruction or a mandated assessment attached to the teaching of science at the kindergarten through fourth grade elementary levels (Missouri Department of Elementary and Secondary Education, 2015). Therein, the amount of science instruction and type of science instruction varies by LEA and teacher within the state of Missouri. Teachers are not accountable on high-stakes assessment for student content knowledge in science until the fifth grade.

Selection of Missouri as a site for research was based not only on convenience but also the demographically diverse population. Missouri is home to small rural communities such as Alma with a population of 393, as well as large urban cities, such as St. Louis with a population of 318,416 (City-Data, 2015). Missouri is also the home of Whiteman Air Force Base, providing a diverse population from which to select participants for inclusion in the study. The sites selected will allow for the “maximum variance” (Creswell, 2013, p. 158) in the sample after identifying individuals who meet the criterion as participants. Inclusion of school sites that serve small rural communities to large urban settings including schools with diverse socio-economic statuses was sought. Inclusion of teachers representing diverse populations in ethnicity, gender, and teaching experience and education were also sought as part of the study.
Participants

The teacher participants are subjects in the study who have experience with the phenomenon who will help to guide the study to develop the composite description of participant’s individual experiences to describe the “meanings and essences of the experiences representing the group as a whole” (Moustakas, 1994, p. 121). The participants in the study were Missouri teachers who taught grades three or four within the past two to three years. Participants were utilized to develop and engage in an extended conversation to deeply understand their experiences (Moustakas, 1994). The participants were self-recognized as teachers who are passionate about science but who feel limited in their science instruction by external factors. The study included five participants. I hoped to include between 3-15 participants with a minimum of one to two from each grade level with the hope to identify five teachers who met the criterion and the possibility to add an additional five to ten if necessary to reach saturation. The sample size in a phenomenological qualitative study should, “typically range from three to ten” (Creswell, 2014, p. 189). This allows one to reach a point in the data collection known as “saturation, when no new data are emerging relevant to an established coding category” (Gall, Gall, & Borg, 2007, p. 469).

The elementary teachers represented geographic regions from around the state and were selected for the “maximum variance” (Creswell, 2013, p. 158). The sample was a purposefully selected sample. The criteria for selection included being a Missouri teacher in the public-school setting in grades three or four who teaches science but feels limited by external factors in his or her science instruction. It was a sample of convenience; in that the participants and sites were located within the same state as myself. Additionally, it was a sample of convenience as potential participants known to the researcher were contacted for participation in the study (Appendix B),
“the individual may be convenient to study because she or he is available” (Creswell, 2013, p. 155). In addition to a sample of convenience participants were sought through snowballing methods such as social media posts (Appendix C) and requests for teachers (Appendix B) and administrators (Appendix D) to share and recruit participants for the study. Snowballing refers to the method of “asking well-situated people to recommend cases to study” (Gall et al., 2007, p. 185).

**Selection Criteria**

Specific criteria were applied to locate research participants who have “experienced the phenomenon” (Moustakas, 1994, p. 107) and who were willing to participate in the research process to discover the essence of the phenomena. The participants were elementary teachers in third and fourth grade self-contained general education classrooms within the Missouri Public School System. The teachers have taught third or fourth grade in the past two or three years. Lower grade level elementary teachers were not included in the sample as they do not take a high-stakes standardized assessment (Missouri Department of Elementary and Secondary Education, 2015) in any content area and would not be a part of the phenomenology to be examined. Teachers of the fifth grade were not included because fifth grade students take a state assessment in science. Thus, teachers would not be part of the phenomenon as the motivation to teach science may be externally rather than due to internally motivation or a shared experience with the phenomenon. The participants were purposefully selected from identified teachers who experienced the phenomenon of teaching science and felt passionate about the content in a non-high-stakes assessment grade level but who felt constrained in their science instruction by external factors. The participants were identified through an email sent to teachers (Appendix B) and administrators (Appendix D) as well as social media posts (Appendix C) which included a
digital flyer in the form of a smore, a website host site of for a digital newsletter, inviting them to participate in the study. Potential participants were provided with IRB approved consent forms (Appendix E) when they were initially contacted and prior to any data collection. They were able to leave the study if they opt out at a later date.

The selection of participants in this study evolved from the initial IRB approval. The stages of change in the study to seek participants was documented. The initial stage of the study called for a purposeful approach to gaining 10 to 15 research participants. The state of Missouri was contacted to determine if approval was needed to conduct research in the state. Then, prior to full IRB approval, the Superintendents of LEAs were contacted to receive permission to conduct research within their district. Emails were sent to the Superintendents of 511 of the 545 public and charter schools within the state of Missouri. The term Superintendent is used to refer to the “school board’s chief executive officer [who] possesses a position of high visibility within the community that is both practical and symbolic” (Razik & Swanson, 2010, p. 382) regardless of the actual title in each district. Sixteen Superintendents granted approval to conduct research within their LEA. Full IRB approval was granted and the principals and 369 third and fourth grade teachers in those districts were contacted to invite them to participate. The criteria for selection was to include Missouri teachers in the public-school setting in grades three and four who teach science on a daily basis throughout the school year using inquiry methods at least two to three times per month. The initial contact was sent in late February and early March after IRB approval and permission to conduct research in the districts had been granted. The time coincided with the month prior to state assessments. A follow-up email was sent to teachers two weeks after the first email. The first request garnered no teacher participants; seven teachers responded but declined to participate.
The second stage of the study called for a change in protocol to allow for a change in the letter sent to recruit the teachers. I made the letter more persuasive and ensure teachers of confidentiality and that the study could be completed at a time that was convenient for them as well as to identify myself as a Missouri educational colleague. A change in protocol was sought and approved by the IRB. The emailed letter was sent to the 16 LEAs who had previously approved to have research conducted in their district and the 362 teachers who had not previously responded were contacted. These teachers were also contacted two weeks after the more persuasively written email letter was sent. The timing of this stage of the research emails fell in with the Missouri state assessment window. The criteria for selection was to include Missouri teachers in the public-school setting in grades three and four who taught science on a daily basis throughout the school year using inquiry methods at least two to three times per month. Seven teachers responded to the email. Five of the teachers declined to participate, while two of them commented on the limits they felt in teaching science. They also mentioned that they did not feel like they met the research criteria. None of the teachers agreed to participate.

The third stage of the study was to change the participation criteria to allow teachers who were passionate about science but felt constrained by external forces to participate in the study. Additionally, the title of the research included on the consent form was simplified to be more encouraging for teachers to participate in the study. Following IRB approval of the change in protocol, new email requests and consent forms were emailed to the 357 teachers who had not previously declined participation and who taught in the 16 LEAs who had given permission to the researcher to conduct research in the districts. The change in protocol did not result in any participants in the study, and one more teacher declined participation.
The fourth stage of the study was to continue with the participation criteria to allow teachers who were passionate about science but felt constrained by external forces to participate in the study as well as to allow teachers who have taught third or fourth grade in the past two to three years to participate even if they had not taught the grade level this past school year. A change in sampling techniques to allow for snowballing and convenience sampling was included. I created a digital flyer and posted it to social media on Facebook and Twitter to garner participants. I also contacted principals and teachers known to me to seek participants. Following IRB approval, the emails and posts were made resulting in five participants agreeing to participate in the study. The emails and social media posts were made after many Missouri school districts were already on summer break. The research consultant was emailed for approval to utilize five participants in the study.

**Procedures**

**Sampling Procedures**

The Missouri DESE website was utilized to identify the school districts in Missouri to compile a list of districts (Appendix A). The Missouri Department of Elementary and Secondary Education does not require researchers to request permission or to notify them of research being conducted in the state. An email was sent to a state official documenting permission requirement prior to conducting research (Appendix A). Following IRB approval, an email (Appendix B) was sent to Missouri teachers of third and/or fourth grade known to the researcher to have taught in the grade level in the past two or three years to invite their participation in the study. An email (Appendix D) was also sent to Missouri administrators known to the researcher who work with teachers of third and fourth grade to invite them to share the information with potential
participants who may want to be included in the study. Social media posts on Twitter and Facebook included a smore, a digital newsletter, to invite participants to the study (Appendix C). Teachers were informed of the voluntary nature of the research at initial contact. A confirmation email or phone call was made to set up the interview (Appendix F & Appendix G). Participants were given the opportunity to conduct the interview, in person, by phone or by WebEx to increase the convenience for them to participate in the study in the initial email and the confirmation email (Appendix B & Appendix F). The study included both teachers of third and fourth grade who self-identified as being part of the phenomenon. Analysis of the demographic information of teachers who expressed interest in participating in the research was conducted to make a purposeful selection to allow for diversity in the sample group. The purposeful sample included teachers of both third and fourth grade self-contained general education classrooms. Documentation was kept detailing the consent of the participants through a consent form (Appendix E) to serve as participants and their inclusion in the sample group.

**Sample Size**

The sample included five elementary teachers which met the need for between 3–15 elementary teachers to reach a saturation point in the data (Creswell, 2013). At a minimum, I sought to include three elementary teachers, one to two teaching at the third-grade level and one to two teaching at the fourth-grade level with the hope to identify and include additional teachers to obtain five to ten participants. An additional five participants were to be sought if necessary to reach saturation in the data. The study included five teachers, two of whom had taught third grade and three who have taught fourth grade. Participants were teachers who have experience with the phenomenon; “a heterogeneous group is identified that may vary in size from 3 to 4 individuals to 10 to 15” (Creswell, 2013, p. 78). Inclusion of participants from each grade level
allowed for articulation of any characteristics within the phenomenon specific to a grade level in the teaching of science that might appear to be generalized to the sample if one grade level contained more representation in the sample. “The validity and meaningfulness is about selecting participants who provide a rich insight into the phenomenon not the number of participants” (Patton, 2002, p. 245). However, a sample that represented adequate research participants was essential to articulating the essence of the phenomenon. The purposeful sample was to ensure a deep understanding of the phenomenon and to spell out the experiences of the participants with maximum transferability of the results.

**Researcher’s Role**

I acted as the “human instrument” (Creswell, 2013, p. 45). The process of research, organizing and collecting data, made me qualified to serve as the instrument to elucidate the essence of the phenomenon. Supported through the utilization of horizontalization to be “receptive to every statement of the participant’s experience . . . and thus encouraging a rhythmical flow between the research participant and researcher, interaction that inspires comprehensive disclosure of experience” (Moustakas, 1994, p. 122).

Inclusion of biographical information about myself is included since “a qualitative report should include some information about the researcher” (Patton, 2002, p. 566). I am April Williams, Ed.S. in Curriculum and Instruction from Liberty University, 2014; M.S. in Administration from Williams Woods University, 2008; and B.S. in Communication Education from Eastern New Mexico University, 1994. I hold teaching certifications in Language Arts (5-9), Social Science (5-9), Speech/Theatre (9-12) and Principal (7-12). In an effort to increase objectivity, I have bracketed out self-experiences with the phenomenon (Moustakas, 1994). I have served as an Instructional and Instructional Technology Coach in a semi-rural district in
Missouri for the past year and in the current school year assumed the role of Director of Student Services/Instructional Technology/Instructional Coaching. I have also served as a District Curriculum and Assessment director or coordinator between 2006 and 2016 with a different LEA, and I have been an educator in the state of Missouri since 1998. I have extensive knowledge and experience with the state standards and assessment practices. Also, I have analyzed and reported assessment scores to the Board of Education, superintendents, and building principals. I worked with district educational stakeholders to change the philosophy of assessment analysis from meeting a proficiency target to looking at cohorts of students to identify and celebrate growth in academic achievement for all students. However, I have also held building principals and teachers accountable to make curricular changes and include interventions when students individually and collectively failed to make growth.

While academic growth is a target for all children and educators, I also fundamentally believe that every child deserves the opportunity to have an educational experience that does not set limits on their potential but rather allows them to enter learning through their talents and abilities. I value each content area as having importance in the educational setting. I also served as the Director of Science, Technology, Engineering, Arts, and Math (STEAM) and wrote and received a three-year one-million eighty-thousand-dollar grant to implement STEAM learning PK-12 in my previous district. “Getting close enough to the situation observed to experience it firsthand means that researchers can learn from their experiences” (Patton, 2002, p. 569). My experiences have helped me to understand the outside forces placed on educators from federal, state, and administration accountability measures. Despite my interest in the topic of science instruction in a high stakes assessment culture, I am not a part of the phenomenon. Other than acting as a substitute teacher on occasion, I have never taught science at any grade level nor have
I ever taught a self-contained general education elementary classroom. Additionally, while I have supported teachers in their efforts to teach students ELA as a remedial reading and language exploratory teacher, I have not been directly responsible or accountable for the high-stakes assessment test results of a grade level of students.

Through the data collection process, I illuminated the experiences of the participants by interpreting the themes that were uncovered through the interviews, questionnaires, and artifacts. Illumination occurred by “segmenting and taking apart the data” (Creswell, 2014, p.194) and then reconstructing the data to represent the collective experience. The educators known to me were not teachers with whom I had evaluator oversight, to eliminate bias in the reporting of the phenomenological experiences. Through interview discussions, “the lived experiences of individuals” (Creswell, 2013, p. 79) was constructed through social interaction and rigorous data analysis. Data collection was conducted carefully and systematically to include interviews, questionnaires, and artifacts that reflected the experiences of the participants with the phenomenon while preserving the anonymity and security of the research data. The data was analyzed deductively and inductively to explain the ontology or viewpoints of reality of the elementary teacher who is passionate about science but feels constrained in science instruction due to external factors.

**Data Collection**

Approval by the Liberty University IRB was sought prior to the collection of data (Appendix H). The IRB plan detailed the data collection process approved and the three sources of data. The use of three sources of data allowed for triangulation, which strengthens a study through consistency (Patton, 2002). Following approval of the IRB plan, I sought approval to conduct research in state LEAs and identification of a purposeful sample was pursued from
participants who met the selection criteria and consented to be in the study. Once consent was obtained, data collection commenced with “face-to-face contact . . . learning firsthand about diverse stakeholders’ perspectives, experiences, and concerns” (Patton, 2002, p. 171). The methods of data collection included a questionnaire and semi-structured interviews with participants, as well as artifacts in the form of a daily or weekly schedule collected from the classrooms of the participant.

**Inquiry Email**

An inquiry email was sent to teachers (Appendix B) and administrators (Appendix D) along with posts on social media (Appendix C) to share a digital flyer in the form of a smore and invite participants to join the study. The potential participants were provided with IRB documents (Appendix E). Teachers who identified as part of the phenomenon were invited to participate in the study and participant responses were reviewed to allow for purposefulness in the convenience sample that allows for “maximum variance” (Creswell, 2013, p. 158). An email (Appendix F) was sent to or a phone call (Appendix G) made to participants to request artifacts and to schedule an interview.

**Questionnaire**

The Science Teacher Efficacy Belief Inventory (STEBI-A) developed and validated by Riggs and Enoch (1990) (Appendix I) was sent to participants to complete on their own along with a request for classroom artifacts in the form of a weekly or daily class schedule in the confirmation email (Appendix F). The STEBI-A (Appendix I) asked participants to respond to statements about their beliefs about teaching science and how teacher’s impact student learning in science. Participants responded to each question by indicating the range of their agreement from strongly disagree to strongly agree. Permission to use the STEBI-A (Appendix J) was
sought and granted for this study. The STEBI-A is a valid and reliable tool; post hoc tests showed no significance among demographic characteristics and the “internal nature of these items in comparison to these of the Science Outcome Expectancy scale may also contribute to its higher reliability” (Riggs & Enoch, 1990, p.12). The questionnaire was analyzed for codes and themes that become evident in the data collection process.

**Questionnaire Interviews**

The STEBI-A questionnaire (Appendix I) was also utilized as the semi-structured interview prompts to elicit more information from the participants. A semi-structured interview is “relatively unstructured, but focused on eliciting all aspects of the experience” (Gall et al., 2007, p. 496). Semi-structured interviews of purposefully selected participants about their experiences were conducted and audio-recorded. The interview was utilized to allow the participants to “discuss the meaning of their experiences” (Creswell, 2013, p. 173). Interview questions and techniques were refined to ensure the interview protocol leads to the discovery of the essence of the phenomena. Additionally, participant responses to the STEBI-A (Riggs & Enoch, 1990) were analyzed with a constructivist and growth mindset frame of reference to develop a “notion of truth” (Patton, 2002, p. 96) about the phenomenon among the participants. Research question responses were analyzed with the Growth Mindset Theory and Social Constructivist Theory and based on the research purpose and questions (Creswell, 2013) were used to record and classify observation codes. Questionnaire interviews were semi-structured and adapted as codes and themes emerged in the research and as participants elaborated on their experiences with the phenomenon. The participants and researcher engaged in some initial discussion to put participants at ease and build rapport before beginning the questionnaire interview to delve deeper into the phenomenon. The questionnaire interview “not only
encouraged detailed narrative, but also high-lighted the complexity of peoples’ views” (Adamson, Gooberman-Hill, Woolhead, & Donovan, 2004, p. 142). The questionnaire interview was found to “provide [a] useful trigger to stimulate conversation on a particular topic and enabled a deeper understanding of the complex factors” (Adamson et al., 2004, p. 143). A copy of the instruments to interview and allow teachers to express their voice can be found in Appendix I. Interviews with participants were set up at a time and place that was convenient for the participant (Appendix F & Appendix G). Participants had the option to interview in person, by phone or by WebEx. The interviews were audio recorded then transcribed verbatim. I then reflexively journaled about the interview documenting the “actualities and the potentialities” (Moustakas, 1994, p. 47) of the experience immediately following the appointment and analyzed the data for themes and codes that became evident through the research process. In a reflective analysis, “the researcher relies primarily on intuition and judgement in order to portray or evaluate the phenomenon...” (Gall et al., 2007, p. 472). The interviews were audio-recorded and transcribed to illuminate the beliefs and attitudes of the teacher through his/her comments to uncover the teacher’s mindset and beliefs about science learning (Dweck, 2006; Vygotsky, 1978). The audio recordings were transcribed and analyzed for themes and codes. As a part of the analysis process, I recorded the general perceptions and response to the interview. The codes discovered were referenced with codes and themes that emerged in the research from each data source. The themes which emerged were compiled to describe the phenomenon.

**Documentation**

Artifacts collected included a copy of the classroom daily or weekly schedule to cross-reference themes and concepts that were identified in the research. Creswell (2013) identified four sources of information which included documents. Classroom documents or artifacts were
collected as part of the research data. The artifacts collected included a daily or weekly classroom schedule. For instance, it was anticipated that the analysis might uncover a theme of teacher autonomy to set a daily schedule and/or a particular inquiry or problem-based lesson design utilized to plan lessons. An artifact or document can serve as a “rich source of information” (Patton, 2002, p. 293). The artifacts were analyzed to illuminate themes and codes from the individual participants. I reflexively journaled about the documentation gathered and the perceptions of how the artifacts support the strategies and beliefs expressed in the interviews and observations. Documentation was triangulated to cross-reference themes and codes that emerged.

The questionnaires, interviews, and artifacts were coded individually for themes and cross-referenced with themes discovered in each data collection process and then compiled together to illuminate the essence of the beliefs, strategies and characteristics of teachers who elected to teach science in a non-assessed grade level. Following data collection an email (Appendix K) was sent to participants thanking them for their time and participation.

Data Analysis

Prior to collecting and analyzing the data, I will epoche (Moustakas, 1994) out my experiences with the phenomenon and high-stakes assessment to review the data from a fresh perspective. A qualitative data analysis software, ATLAS.ti, was utilized to collect, store and analyze data electronically. ATLAS.ti (2002) is a qualitative research analysis software program which allows the researcher to document, code, and analyze data from multi-mediums. Audio recordings, artifacts, and observation protocols will be documented in the ATLAS.ti program for each participant. Participant anonymity was protected using pseudonyms utilized for each participant and building location site. Participants were given a pseudonym to protect their
identity. The pseudonym was utilized across all data collection and was a randomly assigned pseudonym to ensure confidentiality. Password protection was used at each level available to maintain confidentiality and to digitally secure the data. Any paper copies were stored and locked securely in a lock box to which only I have access. The paper copies were coded to the pseudonyms and a pseudonym key will not be kept.

**Inquiry Form**

The initial inquiry email (Appendix B) was analyzed to identify teachers who recognized themselves as being a part of the phenomenon, and who met the criteria for participation in the study. It also documented the participant’s willingness to participate in the research study as well as gather the signed informed consent (Appendix E). The purposeful sample criteria were as follows: serves as a public education teacher in Missouri, has taught either grade three or four in a self-contained classroom within the past two to three years, incorporates science in the elementary classroom and self-identifies as feeling constrained in science instruction by external factors. Within the sample, effort to include purposeful sampling to provide variance in the participants and LEAs within the convenience sample was made. Selection of the participants “focuses on selecting information-rich cases whose study will illuminate the questions under study” (Patton, 2002, p. 231). Identified participants received a follow up email (Appendix H) or phone call (Appendix I) for teachers selected as participants to set up interviews, encourage questionnaire completion, and to request artifacts.

**Questionnaire**

Participants were provided with the STEBI-A (Riggs & Enoch, 1990) to self-reflect and express and identify their personal beliefs about science teaching (Appendix I). The questionnaire data gathered from the participants was analyzed to identify similarities and
differences among the participants to articulate experience with the phenomenon. The codes used were cross-referenced using the “in-vivo codes” (Creswell, 2013, p. 185) uncovered in interviews with the participants to analyze the information discovered.

**Questionnaire Interviews**

Participants were interviewed about their experiences with the phenomenon to obtain “descriptions of experience through first-person accounts in informal and formal conversations and interviews” (Moustakas, 1994, p. 21). Participants were provided with the STEBI-A (Riggs & Enoch, 1990) to self-reflect and express identify their personal beliefs about science teaching (Appendix I). The semi-structured interviews were recorded in a face-to-face setting to capture the verbal and non-verbal communication of the teacher and utilize the STEBI-A (Riggs & Enoch, 1990) as the questionnaire interview (Appendix I). I uploaded the audio recording of the interview into ATLAS.ti and transcribed the interview from the recorded interview to identify the characteristic in the participants. Reflexive journaling was completed immediately following the interviews and uploaded into the qualitative research software. I journaled immediately following the interview to detail perceptions, and themes that came out during the discussion. Then, I analyzed the interview data using coding to identify significant themes and concepts that become evident in the data using the words of the teacher participants themselves or “in-vivo codes, names that were the exact words used by participants” (Creswell, 2013, p. 185) to analyze the data first individually and then compile the data from all the participants. The data gathered from the participants were analyzed to identify similarities and differences among the participants to articulate teacher experience with the phenomenon. The codes which emerged were utilized in analyzing the data gathered from interviews, questionnaires, and artifacts to triangulate the data and discover the essence of the phenomenon.
Documentation

I collected a copy of the classroom daily or weekly schedule to obtain “documents that depict the experiences” (Moustakas, 1994, p. 18) of the phenomenon. The artifacts were uploaded into the ATLAS.ti (2002) program for organization and analysis. Reflective journaling documented the perception of the researcher into the correlation between the artifact and the participants’ perceptions articulated in the interviews and observations. The artifacts were coded for significant themes and concepts and cross-referenced for triangulation with the observations and interview. Digital and paper artifacts such as teacher schedules, and interview notes along with corresponding journal reflections were secured throughout the research process using the ATLAS.ti (2002) program for digital copies and a secured, locked lock-box for paper artifacts. Analysis of the data was first done individually and then a compilation created from the experiences of all participants to describe the experiences of the phenomenon.

Coding

In order to ensure anonymity, pseudonyms were utilized with the participants and sites. The data was analyzed for each participant and coded as it was collected; thus, horizontalizing the data. Horizontalizing is when a researcher considers data by “regarding every horizon or statement relevant to the topic and question as having equal value” (Moustakas, 1994, p. 118) and clusters the statements into codes or themes. I then triangulated the data by analyzing the codes and themes that became evident for each participant individually “constructivism taken in this sense points out the unique experience of each of us” (Patton, 2002, p. 97). Textural descriptions are the “what” of the perceptions of the participants, including “thoughts, feelings, examples, ideas, situations that portray what comprises an experience” (Moustakas, 1994, p. 47).
Analysis of the data was also examined to determine the structural descriptions or “how the participants experienced the phenomenon” (Creswell, 2013, p. 82). The data for the group of participants as a whole was analyzed to identify significant themes and patterns in the data. The textural and structural descriptions were classified for patterns, of the what and how of the phenomenon in order to develop a description of the essence of the phenomenon (Creswell, 2013). The statements will be “clustered into common categories or themes, removing overlapping and repetitive statements” (Moustakas, 1994, p. 118). Coding of the data will also utilize in vivo coding or “the exact words used by participants” (Creswell, 2013, p. 185) to reveal the textural and structural descriptions. After conducting interviews and noting the individual “textural-structural descriptions of all participants’ experiences” (Moustakas, 1994, p. 122), I investigated the data as the human instrument (Lincoln & Guba, 1985) to illuminate and present findings in a compiled composite description.

**Trustworthiness**

Qualitative research analysis was focused on providing assurance that the “results are worth paying attention to and worth taking account of” (Lincoln & Guba, 1985, p. 290). Trustworthiness was established through four criterion credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). The ability of the researcher to describe and analyze data so that there is consistency and truth in the data analysis enriches confidence in the findings. Also, the neutrality of the researcher to objectively report findings adds to the trustworthiness. The use of a qualitative research tool (ATLAS.ti, 2002) increased the trustworthiness of the data by creating a trail which could be followed by other researchers. I sought to increase trustworthiness in the research findings through a description of the efforts to ensure credibility, dependability, confirmability, and transferability.
**Credibility**

IRB approval was sought prior to collection of data (Appendix H). I bracketed out my own views and experiences to increase credibility (Moustakas, 1994). Also, I solicited participants’ views through member checks of “written analyses as well as what was missing” (Creswell, 2013, p. 252) to increase credibility. Dependability provided in the data collection and analysis through member checks and triangulation of the data also increased the credibility.

**Dependability and Confirmability**

Dependability is critical analysis conducted by “the human instrument [who] has the capabilities of summarizing data on the spot and feeding them back to respondents for clarification, correction and amplification” (Lincoln & Guba, 1985, p. 194). An audit trail will be completed of “sufficient detail and description so that the readers feel that they were vicariously in the field” (Corbin & Strauss, 2015, p. 86) to increase dependability. Detailed notes and records were kept throughout the research process and placed in appendices to create an audit trail of the research which could be followed by other researchers. All documentation is stored using the ATLAS.ti program. Audit trail refers to the ability of the external auditor to conduct a review of the research and analysis to provide a judgement about the “quality of data collection and analysis” (Patton, 2002, p. 562). An external auditor was identified to review the audit trail. The external auditor signed a statement of confidentiality to ensure that all information remains privileged (Appendix L). The external auditor reviewed coding and data procedures to ensure that research implementation process was sound and to ascertain the ability to follow an audit trail. The external auditor was an educational professional who had successfully attained a doctorate in education. The external auditor was someone who was not familiar with the project and “who can provide an objective assessment” (Creswell, 2014, p. 202). An external auditor in
the local area to the researcher was sought to implement the process to increase research dependability and confirmability. The external auditor identified was Dr. Kristee Lorenz, a public-school Superintendent who has experience with three school districts in the area of curriculum and instruction and was familiar with the state educational standards and assessments. Additionally, she had experience with STEAM as a former colleague and co-author of the grant I managed. Dr. Lorenz agreed to fulfill the role of external auditor for the study and signed a confidentiality statement (Appendix L). The external auditor “reviewed the documents and verified her research approval, the documentation of dates of approval and interview dates, the Science Teaching Efficacy Belief Instrument Tool Survey, and the security settings on [her] computer that are password protected” (Kristee Lorenz, personal communication, August 16, 2017). A written response to the review was provided to me. Within the written response, the external auditor expressed confidence that my “research journey from readings, writings, data sampling and analysis, and key finding summaries have been conducted with the most ethical and statistically sound process as possible” (Kristee Lorenz, personal communication, August 16, 2017).

Confirmability is the ability for others to review the research and validate the conclusions. A detailed audit trail was established to increase confirmability of the results. Triangulation of the data through the analysis of the phenomenon across sites and through questionnaires, interviews, and artifacts increased dependability as well as confirmability. Additionally, using in vivo coding increased confirmability as they are the “indigenous categories that people interviewed have created to make sense of their world” (Patton, 2002, p. 454).
Transferability

In order to increase transferability “thick description” (Creswell, 2013, p. 246) of the phenomenon will be provided to ensure that the findings apply to teachers involved in the phenomenon. A thick description “presents detail, context, emotion, and the webs of social relationships” (Patton, 2002, p. 503). A thick description also “uses extensive quotations from field participants” (Gall, Gall, & Borg, 2010). Purposeful selection of participants for variance in gender, years of experience, education level, and ethnicity was sought to increase transferability.

Ethical Considerations

I facilitated a sense of reciprocity for the educational field to discover and understand strategies or characteristics of teachers who implement an inquiry science instruction in third and fourth grade elementary classrooms in an assessment-centered educational culture where science is not an assessed subject. Detailed and descriptive information “can be part of the reciprocity of fieldwork . . .” (Patton, 2002, p. 324); in this way a sense of reciprocity was extended to the educational field.

Approval from the Liberty University Institutional Review Board (IRB) was gained prior to embarking on the study to ensure that no harm is done to participants. Risk factors were considered for participants and methodologies to address those stresses will be in place. At the beginning of the research, the assumption was that educators implement inquiry science instructional practices with support of the building principal. Identification of teachers utilizing these methods through principals was focused on the definition of authentic science instruction, not value descriptions of that definition.

Any permissions needed from the instruments, educational agencies, and sites of the participants was attained prior to collection of data after IRB approval (Appendices A, E, & J).
Sites and participants were selected purposefully but they may or may not have a direct interest in the outcome of the study.

Participants signed informed consent forms (Appendix E), were informed of the purpose of the study and were provided the opportunity to withdraw from participating at any time. Participants were given contact information to seek additional information and offered the opportunity to review or member check their transcripts for accuracy. A systematic process was put into place with consideration of “the necessity of confidentiality and informed consent, and developed procedures for insuring full disclosure of the nature, purpose, and requirements of the research project” (Moustakas, 1994, p. 109). A data collection timeline was provided to participants and reminders that were part of the process were also noted.

Trust was established with the participants through open communication about the purpose of the study. Also, the researcher entered the classroom as a researcher and not in a position of any expertise. Respect for the classroom and setting was followed and no evaluation information was shared with the building administrator about the interview. No student data was collected. The only caveat would have been if a situation in which mandatory reporter status had been observed and those responsibilities would have taken precedence for the protection of children, but none was apparent.

Anonymity was preserved by using pseudonyms in data collection, storage files, data analysis and the written study. Participants were informed of archival data which may be linked to participant emails and/or any identifying information; this was included as part of the consent procedures. Participants were asked to remove any identifying information about the participant, building, and/or district prior to sending them to the researcher. The written study was sensitive to the participants and was grounded in research and accurate representations of the data. Data
were collected, names, and locations noted with pseudonyms, and data were stored in a secure manner digitally with a password protected file. Audio tapes and paper formats were locked up to protect anonymity (Creswell, 2013). The information published was made available to study participants if they wished to review it as well as a copy of the study made available to participants upon request.

Ethical advice was sought from the dissertation chair if a significant or study altering event occurred. The professional code of ethics for leaders in the state of Missouri was employed with the participants and the code of ethics from Liberty University also informed practice.

Summary

Throughout the research process, careful, systematic, and rigorous processes were followed to protect the participants and ensure the validity of gathered data. The phenomenological study adds to the body of knowledge and special care and concern was employed to ensure validity and trustworthiness of the findings. The qualitative research discovered the essence of the lived experiences of the participants through ethical and trustworthy research methods designed to uncover the phenomenon of an elementary teacher who teaches science at the elementary grade level but feels limited in his or her science instruction by external factors in an assessment culture where subjects other than science are being assessed.
CHAPTER FOUR: FINDINGS

Overview

The purpose of this phenomenological study was to describe the characteristics of elementary teachers who feel limited in their curricular choices when teaching science in grade levels that are not assessed on a high-stakes assessment. The participants are introduced and their beliefs and characteristics identified. Analysis of the data revealed the essence of the phenomenon and the participants who were at the heart of it.

Participants

The participants in the study were five women from public schools within the state of Missouri. Two semi-rural school districts in the state of Missouri were represented by the participants. These participants ranged in experience from teaching for one year to teaching over the past two decades. Overall, the participants spoke with candor about teaching science in the third or fourth grade. The participants spoke passionately about education and science instruction whether it was their first or 21st year of teaching. They articulated a love for the classroom and their students. The participants were associated with pseudonyms used in the discussion.

“Allison”

“Allison” was the pseudonym for one of the participants. She was a teacher in the middle to last stages of her educational career, having completed 24 and a half years of teaching. Allison taught most of those years in the public-school system. Allison also taught overseas and at a community college for three and a half years. Within the 21 years, Allison taught fourth grade for six years. She taught fourth grade for two of the last three years. Allison spoke softly and used a calm and consistent tone of voice. She reflected on her educational practice as she responded to question prompts. She described her metacognition about her science teaching
practices. She was a Caucasian female in her mid to late forties. She completed her 21st year of teaching in a public-school system, and made statements about education and science instruction to indicate that she enjoys teaching. Allison spoke with confidence about teaching and used clarity when discussing her beliefs and strategies.

“Blanche”

“Blanche” was the pseudonym for a second participant. She was a Caucasian female in her late thirties or early forties. She taught various elementary grade levels throughout her 18- and-a-half-year career. Blanche spent her teaching career in the same public-school district in Missouri. However, she taught within two different buildings during that time. One setting was a middle school and the other was an elementary school. She has taught fourth grade for the past four years. Similarly to Allison, Blanche spoke about enjoying working with students. Blanche was a reflective teacher; throughout the interview, she searched for the most accurate way to describe her experiences with teaching science.

“Caroline”

“Caroline” was the pseudonym assigned to a third participant. She completed her tenth year of teaching at the end of the past school year. Caroline taught a range of grade levels from third to eighth grade. Her experience included teaching in an alternative setting and at different public-school districts in the state of Missouri. In the past three years, she taught third grade for one year and fourth grade for one year. Caroline also taught fifth and sixth grade science for six years in the state of Missouri. The high-stakes assessment for science is given in fifth grade; this perspective added to her conversation as she described her experiences as a third-grade teacher. Caroline was a reflective teacher, who openly discussed areas in which she saw opportunities for herself to grow as an educator. She was a Caucasian female in her late thirties to early forties.
“Dana”

“Dana” was the pseudonym given to the fourth participant. She was a Caucasian female in her thirties who completed her eighth year of teaching. Dana taught fourth grade for seven years and this past year moved to a Title 1 position. Therefore, she taught fourth grade for two of the past three years. Dana completed all her years of service at the same Missouri public-school building. She conveyed a deep concern about intervening for students to meet their learning needs in her responses to the interview prompts.

“Emma”

“Emma” was the pseudonym for the fifth participant. She had one year of experience in teaching. Her first year was completed at a Missouri public school and she taught third grade. Emma was a Caucasian female in her early twenties. Emma lacked some of the experiences of the participants who were farther along in their careers. However, she demonstrated a reflective nature speaking about her desire to do her best for students in her interview. She also identified that believed she could grow as an educator.

The demographics represent the teachers who agreed to participate in the research. Participants represent two districts in the state of Missouri. Participant demographic information was reported including gender, race and age. The participants shared some characteristics and these are reported in Table form.
Table 1

*Participant Demographics*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Race</td>
<td>Caucasian 100%</td>
<td>Minority 0%</td>
</tr>
<tr>
<td>Grade Taught</td>
<td>3rd 40%</td>
<td>4th 60%</td>
</tr>
<tr>
<td>Age</td>
<td>20-29 20%</td>
<td>30-39 20%</td>
</tr>
<tr>
<td>Years Taught</td>
<td>0-10 20%</td>
<td>11-20 60%</td>
</tr>
</tbody>
</table>

Within the individual interviews, artifacts, and questionnaires, codes became apparent. These illuminated in-vivo codes were then compiled to identify the themes in the research. These themes were used in the analysis of the data.
Table 2

*Codes and Themes*

<table>
<thead>
<tr>
<th>Open Codes</th>
<th>Enumeration of open-code appearance across data sets</th>
<th>Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accountability for Learning</td>
<td>18</td>
<td>Responsibility for Achievement</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>43</td>
<td>Strategies</td>
</tr>
<tr>
<td>I always welcome questions</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Inquiry</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Strategies</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Student Interest and Ability</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>You just have to find a different way</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>High stakes assessment influence on time</td>
<td>14</td>
<td>Lack of Time</td>
</tr>
<tr>
<td>Lack of Time</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>I kind of had to teach myself</td>
<td>19</td>
<td>Professional Learning</td>
</tr>
<tr>
<td>Professional Learning</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Inequity in contents</td>
<td>22</td>
<td>Inequity in Contents</td>
</tr>
<tr>
<td>New State Standards</td>
<td>8</td>
<td>New State Standards</td>
</tr>
<tr>
<td>Teacher Efficacy</td>
<td>54</td>
<td>Teacher Efficacy</td>
</tr>
<tr>
<td>Teacher</td>
<td></td>
<td>Teacher Improvement</td>
</tr>
<tr>
<td>Willingness to change</td>
<td>37</td>
<td></td>
</tr>
</tbody>
</table>

The participants responded to the STEBI-A questionnaire as a part of the data collection process. The STEBI-A questionnaire consists of 25 statements. Participants were asked to rate their reaction to each question with their level of agreement. The average response for each prompt is noted.
### Table 3

**STEBI-A Survey Data**

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.</td>
<td>0%</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
<td>Agree</td>
</tr>
<tr>
<td>2. I am continually finding better ways to teach science</td>
<td>40%</td>
<td>40%</td>
<td>0%</td>
<td>20%</td>
<td>0%</td>
<td>Agree</td>
</tr>
<tr>
<td>3. Even when I try very hard, I don’t teach science as well as I do most subjects.</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>40%</td>
<td>0%</td>
<td>Undecided</td>
</tr>
<tr>
<td>4. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.</td>
<td>20%</td>
<td>40%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
<td>Agree</td>
</tr>
<tr>
<td>5. I know the steps necessary to teach science concepts effectively.</td>
<td>0%</td>
<td>20%</td>
<td>60%</td>
<td>20%</td>
<td>0%</td>
<td>Undecided</td>
</tr>
<tr>
<td>6. I am not very effective in monitoring science experiments.</td>
<td>0%</td>
<td>0%</td>
<td>40%</td>
<td>60%</td>
<td>0%</td>
<td>Disagree</td>
</tr>
<tr>
<td>7. If students are underachieving in science, it is most likely due to ineffective science teaching.</td>
<td>0%</td>
<td>80%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
<td>Agree</td>
</tr>
<tr>
<td>8. I generally teach science ineffectively.</td>
<td>0%</td>
<td>20%</td>
<td>20%</td>
<td>60%</td>
<td>0%</td>
<td>Undecided</td>
</tr>
<tr>
<td>9. The inadequacy of a student’s science background can be overcome by good teaching.</td>
<td>20%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>Agree</td>
</tr>
<tr>
<td>10. The low science achievement of some students cannot generally be blamed on their teachers.</td>
<td>0%</td>
<td>20%</td>
<td>20%</td>
<td>60%</td>
<td>0%</td>
<td>Undecided</td>
</tr>
<tr>
<td>11. When a low achieving child progresses in science, it is usually due</td>
<td>0%</td>
<td>60%</td>
<td>40%</td>
<td>0%</td>
<td>0%</td>
<td>Agree</td>
</tr>
</tbody>
</table>
to extra attention given by the teacher.

12. I understand science concepts well enough to be effective in teaching elementary science.

13. Increased effort in science teaching produces little change in some students’ science achievement.

14. The teacher is generally responsible for the achievement of students in science.

15. Students’ achievement in science is directly related to their teacher’s effectiveness in science teaching.

16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child’s teacher.

17. I find it difficult to explain to students why science experiments work.

18. I am typically able to answer students’ science questions.

19. I wonder if I have the necessary skills to teach science.

20. Effectiveness in science teaching has little influence on the achievement of students with low motivation.

21. Given a choice, I would not invite the principal to evaluate my science teaching.

22. When a student has difficulty understanding a
science concept, I am usually at a loss as to how to help the student understand it better.

23. When teaching science, I usually welcome student questions.  

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Very Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. I don’t know what to do to turn students on to science.  

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Very Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

25. Even teachers with good science teaching abilities cannot help some kids learn science.  

<table>
<thead>
<tr>
<th></th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Very Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The participants also shared their classroom schedules to identify the amount of time that was spent teaching science. There were some similarities within the amount of time that was spent in teaching the content areas. The artifact was used to uncover the instruction expectations for science learning in the fourth and third grade in the state of Missouri. Allison shared a limited schedule which identified the time spent in teaching science but did not detail the other minutes spent in all of the other content areas. She did comment that her schedule was a four day a week schedule for teaching science or social studies. Blanche’s schedule reflected that she taught science and social studies in alternate semesters. The schedules reflected the information in different manners for some the time set aside for the content also reflected the lunch time or two content areas combined.
Table 4

Classroom Schedule Minutes

<table>
<thead>
<tr>
<th>Content Taught</th>
<th>Allison</th>
<th>Blanche</th>
<th>Caroline</th>
<th>Dana</th>
<th>Emma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>-</td>
<td>45</td>
<td>75</td>
<td>80</td>
<td>75</td>
</tr>
<tr>
<td>Reading</td>
<td>-</td>
<td>110</td>
<td>120</td>
<td>120</td>
<td>135</td>
</tr>
<tr>
<td>Writing</td>
<td>-</td>
<td>50</td>
<td>75</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td>Total ELA</td>
<td>-</td>
<td>160</td>
<td>195</td>
<td>180</td>
<td>255</td>
</tr>
<tr>
<td>Science</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Social Studies</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Science/SS</td>
<td>45</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>35</td>
</tr>
<tr>
<td>Science/SS/ReadingRTI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>30</td>
<td>-</td>
</tr>
<tr>
<td>Specials</td>
<td>-</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Opening</td>
<td>-</td>
<td>45</td>
<td>-</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Lunch</td>
<td>-</td>
<td>24</td>
<td>25</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>End of Day</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Recess</td>
<td>-</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Results

The study focused on the following central question. What are the experiences of elementary teachers in Missouri who chose to include instruction using authentic inquiry-based science content instruction in an educational culture centered on assessment in math and ELA? Although the teachers who participated in the study were from two different LEAs, analysis of
the data found the experiences of elementary teachers to be similar when they chose to include instruction using authentic inquiry-based science content instruction.

Lack of time in the elementary classroom for science instruction was one common theme in the data. Dana’s classroom schedule reflected that from 1:00-1:30 was Reading Response to Intervention (RTI) time and science/social studies, indicating the 30 minutes was to be used for multiple purposes daily. RTI refers to “early intervention to all children at risk for school failure,” (Fuchs & Fuchs, 2006, p. 93), in other words a time in the schedule to provide instruction to help students be successful in their learning. This was also reflected in Blanche’s classroom schedule which did list social studies/science time from 12:10-1:30. However, 30 minutes of that time was designated for lunch and a restroom break. The time delimitation did not remark on transition to and from the lunch location. Within the interviews, all of the participants mentioned the lack of time they felt they had to teach science. Blanche said, “It [science] is always that thing you fit in between things” (Blanche, personal communication, June 13, 2017). While Caroline mentioned in the interview, “I wish we had more time” (Caroline, personal communication, June 15, 2017). The sentiment was echoed by when Dana said, “I just get so disappointed with like the time schedule and not having more” (Dana, personal communication, June 15, 2017). This thought was expanded on by Emma who shared that she would not mind being observed during science time because then the principal might realize, “Wow, that is really not enough time to do this” (Emma, personal communication, June 28, 2017). This comment was supported by all the participants who disagreed with the STEBI-A survey prompt “Given a choice, I would not invite the principal to evaluate my science teaching” (Riggs & Enoch, 1990, p. 635). Caroline expressed the lack of time issue more fully saying, “we need to find in our schedules that we have science every single day in third and fourth grade”
Therein, one of the shared experiences was a lack of time in the schedule for teaching science.

The influence on the time schedule did vary slightly for the participants. The classroom schedule, for Caroline, was determined by the principal. Allison talked about the decision of her team to set the schedule. This sentiment was echoed by both Blanche and Emma. However, Emma’s comments expressed the idea that the experienced or senior teachers who had been on the team previously set the schedule, “whenever we first started planning they were like this is what we did, this is what we have always done, so this is what we are thinking we are going to do this year” (Emma, personal communication, June 28, 2017). Dana indicated that the district and building focus was shaped by high stakes assessment with this statement, “there has been such a push to improve our MAP scores, improve our MAP scores that the focus in our building has just been reading and math” (Dana, personal communication, June 15, 2017). MAP refers to the Missouri Assessment Program which is the high-stakes assessment for the state (Missouri Department of Elementary and Secondary Education, 2016). Thus, the lack of time in the daily classroom schedule was influenced by the participant’s fellow team members, administrator and the focus on increased assessment scores.

The shared experience of lack of time prompted teachers to articulate strategies for incorporating or finding more time to include science in their own classrooms. Allison talked of having the same time set aside for social studies and science. Therefore, her team chose to rotate content by teaching first a science unit and then a social studies unit rather than rotating between science and social studies daily. This was reflected on her schedule. She did comment that this “is not really exposing kids to a full year through every quarter” (Allison, personal communication, June 12, 2017). Blanche talked about rotating science and social studies
quarterly in order to have more consistent time to teach. Caroline’s team decided to teach science one semester of the year and social studies the next semester. This is a similar experience that Emma had with science instruction. However, she felt that it was not as effective for her personally because it was her first semester as a teacher and her team had divided planning responsibilities by content. Thus, she only experienced teaching science for one semester and was not responsible for planning the grade level content. Blanche also mentioned teaching a STEAM class to incorporate exploration during summer school because she has “two hours with the kids and I could just kind of let them lead me more so it was a little less restrictive” (Blanche, personal communication, June 13, 2017). The participants found methods to provide more time for science experiences for students in their classrooms. However, they all commented on the lack of time and the desire to provide students with a more hands-on investigative experience in science which includes, “consistency and time” (Caroline, personal communication, June 15, 2017).

The study of the phenomenon of Missouri elementary teachers who felt strongly about science but limited in science instruction revealed shared beliefs. What are the beliefs of Missouri teachers choosing to teach science in non-assessed grades? (SQ1) The beliefs articulated in the interviews, survey and artifacts of the participants revealed a picture of the mindset of the teachers, the belief of strategies implemented in the classroom and a philosophy of the responsibilities of an educator.

The mindset revealed by the teachers was a willingness to change. Regardless of the experience level of the teacher, each participant expressed a sentiment that spoke to her own willingness to change, to learn and grow in her educational practice. When discussing finding better ways to teach science, Emma commented, “I definitely feel like that’s somewhere I could
really grow” (Emma, personal communication, June 28, 2017). The participants agreed at 80% that they are continually finding better ways to teach science, demonstrating a willingness to change their educational practice. Blanche expanded on this thought by stating, “I feel confident as a science teacher, but I am always looking and trying to find more” (Blanche, personal communication, June 13, 2017). This comment was replicated by Caroline who said, “I am always looking for better ways to teach science um always reflecting on the way the lesson has gone or the year has gone in teaching science” (Caroline, personal communication, June 15, 2017). Allison made a similar comment when discussing knowing the steps necessary to teach science concepts effectively. She said, “I know some of them, but that goes back to always wanting to improve” (Allison, personal communication, June 12, 2017). Dana shared a common viewpoint and said, “I don’t like to do things ineffectively, so, I personally put a lot of effort into it” (Dana, personal communication, June 15, 2017). On this particular survey question, 60% of the teachers were uncertain if they taught science ineffectively. While this seems to contradict the statements made during the interview, the conversation really highlighted the reflective nature of the teachers and a willingness to change and not accept that they did not have opportunities for growth to make the most of the time articulated on the survey for science instruction. These comments illustrated a willingness to change, refine, and grow in instructional practice.

Another theme highlighted in the data was the strategies to be implemented in the science classroom. Dana mentioned that, “science is inquiry” (Dana, personal communication, June 15, 2017). She also described “hands-on activities” (Dana, personal communication, June 15, 2017). Caroline talked about “hands-on,” “STEM,” “teaching through the scientific method,” and “experiments” (Caroline, personal communication, June 15, 2017). Emma talked about “hands-
on,” “experiments,” and integrated learning (Emma, personal communication, June 28, 2017). Blanche talked about “cross-curricular,” “time to explore,” “doing an activity,” and “hands-on” (Blanche, personal communication, June 13, 2017). Allison referenced “hands-on,” “STEAM,” “demonstration,” and “experiment” (Allison, personal communication, June 12, 2017). These terms or codes were alternatives for inquiry and scientific experiments. On the survey, 100% of the participants disagreed with the statement, “I don’t know what to do to turn students on to science” (Riggs & Enoch, 1990, p. 635). The teachers described strategies of inquiry based learning (IBL) and hands on activities and experiments to engage students in what has been identified in research as authentic science instruction.

A third shared theme or belief of the participants involved in the phenomenon was a responsibility for education and a belief that all students can learn. This belief extended to identify science as a content for all students. The participants agreed or strongly agreed by 100% that, “the teacher is generally responsible for the achievement of students in science” (Riggs & Enoch, 1990, p. 635). Allison revealed this philosophy when she commented,” I think teachers really have a lot of influence in each child’s learning [so] no matter what the capabilities of that kid” (Allison, personal communication, June 12, 2017). She said this in disagreement with the comment that, “the low science achievement of some students cannot be generally blamed on their teachers” (Riggs & Enoch, 1990, p. 635). This viewpoint was mirrored by Caroline who noted, “if they [students] are achieving low in anything, our job is to teach and if they are not achieving then we need to figure out what we are doing wrong” (Caroline, personal communication, June 15, 2017). Dana shared this view of teacher accountability to help all students stating, “that is just our job as educators to help make it easier for them” (Dana, personal communication, June 15, 2017). Emma made a similar point as she stated an
accountability for using methods to help students be successful, “in education if we can find more ways to be effective with kids then it is going to stick with them” (Emma, personal communication, June 28, 2017). It was Blanche who identified third and fourth grade teachers as accountable for science instruction despite not taking a high stakes assessment, “I think every grade level teacher should be held to the same responsibility level” (Blanche, personal communication, June 13, 2017). The participants all held the belief that the teacher is accountable for learning. This belief was supported in the manner in which they answered the survey questions and responded to the interview and the manner in which they addressed the lack of time in their classroom schedules for science instruction.

Teacher efficacy or the idea that a teacher can produce a desired result was also identified in the comments of the participants during the interviews as well as on the surveys. Although, no participant expressly used the term teacher efficacy, they all made comments that referred to the belief that teachers make an impact on student achievement. Emma commented, “I believe that every single child can succeed no matter what subject [it] is” (Emma, personal communication, June 28, 2017). She later also stated, “if that teacher is finding effective ways to teach it, then they are going to achieve” (Emma, personal communication, June 28, 2017). A belief that all students can learn and that the teacher is an agent of learning was shared by Dana, “an effective teacher is going to push them [students] higher” (Dana, personal communication, June 15, 2017). Caroline shared Emma’s belief in student learning stating, “I think every kid can learn science” (Caroline, personal communication, June 15, 2017). She also observed about teaching, “You have to find a better teaching approach for them to be able to improve their scores and grades” (Caroline, personal communication, June 15, 2017). Blanche also spoke of the teacher’s ability to reach intendent outcomes saying, “a teacher can excite students and can help them” (Blanche,
personal communication, June 13, 2017). This belief was also maintained by Allison who said, “in a majority of cases teachers can reach kids one way or another” (Allison, personal communication, June 12, 2017). On the survey, participants responded in agreement by 60% to the statement, “when the science grades of students improve it is most often due to their teacher having found a more effective teaching approach” (Riggs & Enoch, 1990, p. 635). While 100% of the participants disagreed with the statement that, “even teachers with good science teaching abilities cannot help some kids learn science” (Riggs & Enoch, 1990, p. 635). All of the participants or 100% agreed that, “the inadequacy of a student’s science background can be overcome by good teaching” (Riggs & Enoch, 1990, p. 635). The participants also agreed that students’ achievement in science is directly related to their teacher’s effectiveness in science teaching. The survey results as well as the comments of the participants in the phenomenon identified a similar belief that teachers impact student learning and make a difference in that achievement despite the identified lack of time noted on the teaching schedules.

The data answered the question, what are the strategies teachers take to provide authentic science instructional format to teach Missouri Learning Standards? (SQ2) The participants all agreed on the STEBI-A that, “the inadequacy of a student’s science background can be overcome by good teaching” (Riggs & Enoch, 1990, p. 635). One of the strategies implemented, by the participants, was to garner more time for their own classrooms to provide science instruction. The participants described in the interviews what science teaching looked like. Dana and Blanche described literacy as a key part of science instruction. They described the need to develop vocabulary skills with students in order to help those who struggle with language to assist them in developing science concepts; “science is such a vocabulary based subject and it is so hard sometimes for our language students” (Dana, personal communication, June 15, 2017).
Blanche described the strategy of incorporating science with reading in order to provide more time for science content, “You have to be creative at elementary level” (Blanche, personal communication, June 13, 2017). Allison, Blanche, Caroline, Dana, and Emma all discussed the need to integrate content areas mentioning STEAM or STEM as well as preparing students to be scientists or engineers. Experimentation was discussed in a variety of participant comments and was associated with multiple terms. It was suggested that teachers could find a place to start teaching science with the scientific method. Then, it would be logical if they, “taught the standards through the scientific method” (Caroline, personal communication, June 15, 2017). The STEBI-A revealed an average response of disagree to the prompt, “I am not very effective in monitoring science experiments” (Riggs & Enoch, 1990, p. 635). The participants expressed the idea that they were effective at monitoring science experiments, “that was one of my favorite parts of teaching science” (Dana, personal communication, June 15, 2017). Emma expressed that experiments are, “really intriguing to me to see how a different group can see something different or notice something different than another group did” (Emma, personal communication, June 28, 2017).

The data also answered the question, what are the characteristics of teachers who do not only teach to the test, as evidenced by teaching science in a non-assessed grade? One characteristic was an excitement and passion for science and science instruction. The participants all shared an enthusiasm for the content. Dana stated, “there has to be extra attention and drive and love for the subject to help those to meet those student’s needs” (Dana, personal communication, June 15, 2017). Caroline extended this thought with her comments, “I think that science can be something that you can take students with low motivation and pull them in to loving school” (Caroline, personal communication, June 15, 2017). Allison mentioned, “I just
think that science is so hands on and it is a delight to see the students doing stuff and working together” (Allison, personal communication, June 12, 2017). The benefit of seeing students excited about learning a topic that was not as exciting to teach was described by Blanche, “once you get those kids going and [they] you see how excited they are . . . then, it’s like oh this is actually really fun but you have to have an open mind for it” (Blanche, personal communication, June 13, 2017). Emma said, “I have always loved science, it has always been one of my favorites” (Emma, personal communication, June 28, 2017). While there was not direct correlation with a particular STEBI-A question, the participants all shared the characteristic of a passion or excitement for science and science instruction.

Another characteristic exposed by the interview was the lack of training or preparation for science instruction which led the participants to seek and learn for themselves. Both Dana and Allison” commented on the lack of professional learning and training for teachers in teacher preparation programs. Dana stated, “there should be more of a focus on training and more resources provided” (Dana, personal communication, June 15, 2017). When asked the prompt “if students are underachieving in science, it is most likely due to ineffective science teaching” (Riggs & Enoch, 1990, p. 635), Allison commented, “I feel strongly that science is a wonderful field . . . I guess that would go back to the teacher being under trained or not effective” (Allison, personal communication, June 12, 2017). In the interview, she noted that for her own professional learning, she, “kind of had to teach myself” (Allison, personal communication, June 12, 2017). Dana mentioned the need to understand the standards and, “put a lot of extra energy and time outside of school into it” (Dana, personal communication, June 15, 2017). Blanche made a similar comment when talking about her willingness to learn and answer student questions and the need “to be open to educating yourself” (Blanche, personal communication,
June 13, 2017). Emma also referred to the need to “look it up at home” to answer student questions and a willingness to continue her learning (Emma, personal communication, June 28, 2017). While Caroline talked about the need to conduct more research in her teaching to present content to students, “I always try to make sure that I’ve researched or understood it” (Caroline, personal communication, June 15, 2017). The lack of training and characteristic of the participants to learn for themselves was supported by the STEBI-A survey statement, “I am continually finding better ways to teach science, 80% of the participants agreed or strongly agreed” (Riggs & Enoch, 1990, p. 634). Although the participants shared a lack of professional learning in the science content, the characteristic they had in common was a willingness to teach themselves.

Finally, a characteristic shared by the participants was a desire for things to change and for science to be recognized and valued as a core content area. The MAP test or high stakes assessment played a role in science instruction. Blanche remarked, “You know you are responsible for math that’s what we are tested over but science and social studies are kind of left to inconsistent results I feel like, because there is no one holding people accountable with that” (Blanche, personal communication, June 13, 2017). While talking about her science schedule, Allison said, “We really stressed the math and ELA and the science and social studies were disadvantaged by that” (Allison, personal communication, June 12, 2017). The idea that science was not treated as a core subject was further explained by Caroline who said, “we really, really focus on reading and writing and math but science we don’t, we don’t focus on it as a core subject at all” (Caroline, personal communication, June 15, 2017). Dana corroborated this statement when she said, “science in our district and social studies seem to have always taken the back burner” (Dana, personal communication, June 15, 2017). While Emma talked about not
giving a MAP assessment in science at the third-grade level and the result was the grade level team determining that, “we don’t need to put that on the forefront, to put it kind of on the back burner” (Emma, personal communication, June 28, 2017) Within the comments was the devaluation of science for tested areas, and the characteristic shared by the participants was a desire for change.

The identified themes answered the research questions. Examination of the teacher efficacy, inequity in contents, and the responsibility for achievement answered the first research question. What are the beliefs of Missouri teachers choosing to teach science in non-assessed grades? (SQ1) The beliefs included a belief that the teacher impacts student science achievement. Analysis of the themes, lack of time, new state standards, inquiry, and strategies, addressed the second research question. What are the strategies teachers take to provide authentic science instructional format to teach Missouri Learning Standards? (SQ2) Among these strategies was inquiry and scientific exploration. The third research question was answered by the themes inquiry, teacher efficacy, professional learning, and teacher improvement. What are the characteristics of teachers who do not only teach to the test, as evidenced by teaching science in a non-assessed grade? (SQ3) A willingness to learn for themselves how to teach science was a common characteristic. The themes and sub-questions allowed the central question to be answered. What are the experiences of elementary teachers in Missouri who chose to include instruction using authentic inquiry-based science content instruction in an educational culture centered on assessment in math and ELA? (CQ) The participants used strategies to maximize instructional time in their classroom schedule to include science instruction.
Summary

The participants provided data that answered the research questions about the phenomenon of being a third or fourth grade teacher in the state of Missouri who was passionate about science but felt limited in their science instruction. The participants demonstrated shared characteristics that included a desire for change, a willingness to teach themselves, and a passion for science and/or science instruction. Further, the participants noted scheduling factors which limited their science instruction and included the academic teams on which they were placed, administrators, and focus on the contents assessed with the state high-stakes assessment. The triangulated data from the participants’ classroom schedules, STEBI-A survey results, and interviews illustrated the phenomenon.
CHAPTER FIVE: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Overview

The purpose of this phenomenological study was to describe the characteristics of elementary teachers who feel limited in their curricular choices when teaching science in grade levels that are not assessed on a high-stakes assessment. The study reaffirmed current literature and identified strategies that teachers utilized for incorporating science into their classrooms. It also identified areas for change within current educational practice.

Summary of Findings

Teachers who taught third and fourth grade in a public school in Missouri and were passionate about science but felt limited by external factors in their science instruction were part of the same phenomenon. What are the characteristics of teachers who do not only teach to the test, as evidenced by teaching science in a non-assessed grade? (SQ3) Research illustrated the experience of the participants and identified these teachers as having some of the same characteristics. These characteristics included a passion for the content and science instruction, a willingness to teach themselves, and a desire for things to change. What are the strategies teachers take to provide authentic science instructional format to teach Missouri Learning Standards? (SQ2) The participants identified authentic methods for teaching science using terms that reflect scientific exploration, inquiry, and hands-on integrated learning. What are the beliefs of Missouri teachers choosing to teach science in non-assessed grades? (SQ1) Research identified the beliefs of the participants involved in the phenomenon to be a mindset with which they sought to grow and develop as an educator, the belief that the teacher could seek strategies to implement science and a belief that the educator has a responsibility for student learning and a belief that all students can learn. What are the experiences of elementary teachers in Missouri
who chose to include instruction using authentic inquiry-based science content instruction in an educational culture centered on assessment in math and ELA? (CQ) The participants in the phenomenon shared a vision of education in which their daily schedule is often set for them or influenced by others. However, the teachers in the phenomenon demonstrated a commitment to the content by finding ways to get around the time restrictions to offer authentic science instruction in the third and fourth grade classrooms. Additionally, the participants identified the limitations as the daily schedule, a focus on assessed content areas, the idea that science is treated as a non-core and an internal drive or empowerment to identify strategies to offer authentic science instruction for students.

**Discussion**

Theoretically, the study illuminated participants who held a growth mindset, (Dweck, 2006) believed in constructivism approaches to learning and found value in social constructivism to build knowledge and desired that type of learning opportunity for their students and themselves. The participants described science instruction using terms that represented a constructivist viewpoint, “having kids investigate science topics and be hands on with things and work in teams to do Steam type activities” (Allison, personal communication, June 12, 2017). Constructivist learning includes “curiosity, inquisitiveness, autonomy, independence of mind, freedom from external authority, and a personal search for meaning about the world are the qualities that scientists possess” (Deboer, 2002, p. 407). Social Constructivism was evident in the study through the comments teachers made about collaborating with colleagues but also in the value of having students interact with one another. The Social Constructivism Theory is the idea that knowledge is built from “learning how to successfully interact” (Allen & Bickhard, 2011, p. 165). Building knowledge through labs and experiments was described by Emma who said it is,
“really intriguing to me to see how a different group can see something different or notice something different than another group did” (Emma, personal communication, June 28, 2017).

The study corroborated current literature. Content professional learning of teachers was identified as being needed, “transforming teacher beliefs is fundamental to enduringly transforming their understanding and practice of inquiry in their classroom” (Herrington et al., 2016, p. 184). An idea supported in my research by participants, as Allison phrased it, “I needed more training” (Allison, personal communication, June 12, 2017). Authentic science instruction in the classroom occurs when, “teachers create opportunities for their students to learn inquiry skills and to reflect on inquiry” (Capp, Crawford, & Constas, 2012, p. 294). This was also supported by my research, each of the participants mentioned inquiry and experiments. Caroline commented science should be a content in which one, “taught the standards through the scientific method” (Caroline, personal communication, June 15, 2017). This is an ideal that supports the research of Bernhardt (2015), Isikoglu, et al., (2009) and Nadelson et al. (2013), who noted that only some teachers choose to teach authentic science through the use of the scientific method and exploration. The study clarified this issue by identifying concerns with the MLS science standards, “I feel like the standards when they changed were very, very unclear” (Caroline, personal communication, June 15, 2017). One potential reason for this may be organization of the content, “I wish that our standards were more unit based instead of here’s something and here’s something” (Blanche, personal communication, June 13, 2017). A second potential reason may be around professional learning and the time to develop an understanding of the standards was also noted, “Our old standards yes, the new ones I am not for sure” (Dana, personal communication, June 15, 2017). The participants further supported current research by remarking on the focus of instructional time toward math and ELA. An idea maintained by the
participants’ daily class schedules which revealed that Emma spent 75 minutes in math and three hours and 15 minutes in ELA instruction compared to the 35 minutes allotted to science. While Blanche spent 75 minutes in math and two hours and 40 minutes in ELA instruction compared to the 20-30 minutes allotted to science when having to also have a lunch break in the schedule and the 60 minutes a day spent in morning work/planners and end of the day clean-up. The disconnect between the participants’ beliefs and desire to teach using inquiry and the time schedule reflected the study completed by Singer et al. (2000). Further it supports the research which “suggests that science is virtually ignored in the elementary grades” (Cotabish et al., 2013, p. 16).

My study in many ways substantiated current empirical and theoretical research. However, my study extended previous research to address the phenomenon for a particular group of teachers, those teachers in Missouri public schools who teach third or fourth grade who were passionate about science and motivated to include science inquiry in their classroom but were limited in their science instruction. The study extended the learning in previous studies by examining some strategies teachers utilized in an attempt to offer more time for science in their classrooms. The study demonstrated the growth mindset of the participants who were willing to teach themselves to become more effective teachers for their students. The participants understood that there is “a changeable ability that can be developed through learning” (Dweck, 2006, p. 15). The participants demonstrated a willingness to seek this change in their own abilities for themselves and their students. Another way this study added to previous research was in what it revealed about the participants. The participants were at once compliant and seeking autonomy in their practice. Although the participants revealed a feeling that they were limited in their science instruction based on a time schedule that was set by their administrator or
with a grade level team of teachers, they did not confront the situation demanding change. Rather, they implemented strategies in collaboration with the team or autonomously as an individual teacher to increase the authentic science experiences of students. The participants time and again used words associated with the construction of knowledge, Allison, Blanche, Caroline, Dana and Emma all used words such as, “hands-on, authentic, STEAM, STEM, and inquiry” (Allison, personal communication, June 12, 2017; Blanche, personal communication, June 13, 2017; Caroline, personal communication, June 15, 2017; Dana, personal communication, June 15, 2017; Emma, personal communication, June 28, 2017). An interesting dichotomy was revealed, which was the participants were willing to comply with expectations, but felt they had some autonomy in making curricular decisions in the classroom. I believe this is important to note because none of the teachers challenged or changed the schedule to include more time for science instruction, despite the articulated enjoyment and passion for the content. Instead, they worked within the system to offer more opportunities for inquiry science instruction. It is unclear if this is because of a fear of evaluation, assessment scores dropping, a desire to avoid conflict within the grade level team or simply an acceptance of this is how it is done. Further, the participants described a growth mindset classroom in which students were challenged and cared about, “great teachers set high standards for all their students, not just the ones who are already achieving” (Dweck, 2006, p. 196). Another way the research added to the current literature was the interaction with high stakes assessment. Current literature also identified that, “teachers believed that NCLB resulted in less science being taught at the elementary level” (Milner et al., 2012, p. 127) The participants recognized that they were limited in science instruction because of a focus on math and reading content areas which were assessed on high stakes assessments; “before the MAP test we would double dip on Math and Comm. Arts and just push science and
social studies off” (Allison, personal communication, June 12, 2017). Current research identified that high-stakes instruction had an impact on the amount of time spent in teaching science (Wills & Sandholtz, 2009; Milner et al., 2012, Cotabish et al, 2013; Lumpe et al., 2012; Johnson et al., 2012). The participants identified this as science being a non-core [discipline], or at least being treated that way (Caroline, personal communication, June 15, 2017; Dana, personal communication, June 15, 2017; Emma, personal communication, June 28, 2017). A picture was painted of the content as a non-focus, one which was not discussed in data teaming, professional learning or even in hallway conversations (Emma, personal communication, June 28, 2017).

What this study added to the current research was a revelation about accountability. Participants mentioned that they would be willing to assume accountability in teaching science as a means of receiving feedback and increasing the focus on science as a core content area. A thought supported in their STEBI-A Survey results. Accountability in science on a high stakes assessment or at the local level was not off-putting or frustrating to the teachers but was rather a desired outcome (Caroline, personal communication, June 15, 2017; Blanche, personal communication, June 13, 2017). In light of a social constructivism view, the participants described a situation in which they were left to teach themselves if they wanted to grow and develop as a science educator. The situation was not one in which they were able to grow collaboratively in science learning. In the words of Caroline, “you do need feedback from someone who knows what the expectations are” (Caroline, personal communication, June 15, 2017). The study extended the current literature by illuminating teachers in a non-assessed grade level who welcomed accountability in teaching all content areas and a desire to implement strategies for authentic science instruction for all students.
Implications

The theoretical implication of this study was that if science continues to be taught as a “non-core” then it may impact the current generation of learners and the state of Missouri. Students in Missouri do not spend extended time in the content to develop deep levels of knowledge; “I don’t feel like we got to dig in as deep with science or social studies because we just had you know tiny, tiny amounts of time to be able to do it” (Emma, personal communication, June 28, 2017). The empirical implication was that if science instruction does not change in the state of Missouri, fewer students will grow up to love science and want to enter those related career fields. When discussing science experiments, Dana said, “If you want to create scientists and engineers and those types of careers [umh] you have to let them see where their mistakes are and see how to fix it” (Dana, personal communication, June 15, 2017). This implication would be not only harmful in the knowledge base and potential career sense, but, would have far reaching impacts as fewer individuals experienced making science relevant and inquiry based instruction at the elementary level. Allison expanded on the lack of training for teachers in and need for science inquiry.

I do know that having kids investigate science topics and be hands on with things and work in teams to do STEAM type activities, I know those are good and right and very valid and valuable ways to teach science through exploration. I needed more training.

(Allison, personal communication, June 12, 2017)

A practical implication is that a failure to refocus on science instruction at the elementary level will lead to decreased achievement in science at the middle and high school levels. Student knowledge takes time to build, “we have to have our students prepared to be able to [well] to have a basic knowledge of science” (Caroline, personal communication, June 13, 2017).
Based on these implications, the following recommendations for teachers, administrators and policy makers might be considered. First, the recommendation for teachers is to be a voice to incorporate science at the elementary level in their classrooms, instructional strategies discussions, and curriculum planning sessions. Second, a recommendation for administrators is to create classroom schedules that give value to each of the content areas, hold teachers accountable, and offer feedback for effective science instruction. Third, another recommendation for administrators is to seek professional learning opportunities for teachers in the area of science instruction and provide time at the collaboration table for discussion about science instruction and learning. Fourth, a recommendation for policy makers is to add a time component to the requirements for science instruction and define for teachers what “regular instruction” (Missouri Department of Elementary and Secondary Education, 2015, para. 2) looks like in the content area. Fifth, a recommendation for administrators and policy makers is to change their own perspectives to identify and focus on science as a core content area and a key component in being college and career ready.

**Delimitations and Limitations**

The study was delimited to include public elementary school teachers. Public school teachers were included in the study as they are held to the same state standards, which may not apply to teachers of private and Christian institutions allowing for selection of participant sites that share the same phenomenon. The public elementary school teachers were selected among teachers of the third and fourth grades in the state of Missouri as these teachers share the same learning standards, teaching indicators, and high-stakes assessments. Further, the study was delimited to self-contained general education classrooms or a classroom in which “the children are taught all subjects by one teacher” (Lobdell & van Ness, 1963, p. 212). The study did not
include settings in which the grade level team specialized and provided content area instruction in core areas. Additionally, the study delimited science instruction to mean the inclusion of authentic science instruction through the use of science inquiry and skills. Authentic science instruction was defined as scientific exploration through all stages of the scientific process from the generation of testable questions to “constructing and evaluating scientific arguments based on evidence” (Minner et al., 2010; Nowicki et al., 2013, p. 2). Science inquiry applies knowledge to real-world problems to help students understand the outside world through encouragement to use inquiry and to accept those answers that are supported by evidence (Bruce-Dais et al., 2014; Engeln et al., 2013). The National Science Teachers Association (NSTA) identified that “research shows that engaging in the practices used by scientists and engineers plays a critical role in comprehension” (National Science Teachers Association, 2014b, para. 2).

Limitations in the research were “criticisms that may be made of a particular sampling strategy” (Patton, 2002, p. 242). The limitations for the study were rooted in the fact that the sample was a convenience selection which includes only teachers from the state of Missouri. One limitation was that selecting Missouri teachers may impede the transferability of the conclusions to teachers in other state systems. Another limitation was that the study was narrowed in on the experiences of teaching science in a high-stakes assessment educational culture and may not be the same experiences shared by teachers who elect to include art, music, social studies, and other non-assessed content areas in their instruction. Additionally, a limitation was that the study only included elementary teachers of grades three and four; this may impact transferability to elementary teachers of other grade levels as well as to teachers at the secondary level.
The research study did have other limitations. The first limitation was the ability to garner more participants to the study. Therefore, the diversity of the participant demographics was a limitation to the study and may limit transferability. Additionally, the teacher participants came from two semi-rural school districts in Missouri, which may also limit transferability to other teachers involved in the phenomenon. Another limitation was that the two or three elementary schools, in the state of Missouri, identified as STEM/STEAM schools did not participate in the study and might have different strategies and beliefs which were not represented by the participant population. Finally, a limitation in the study was that the participants were known to the researcher, although teachers across the state were invited, only five responded with a positive response. While this is a limitation on one hand, it also was a point of strength as the participants responded to the interview prompts with candor and trust. A weakness of the design was that the timing of the research which coincided with a transition of the math, ELA, science, and social studies Missouri Learning Standards (MLS) and a school year which found Missouri teachers with additional curriculum development responsibilities. The coincidence of the timing may have impacted teachers’ ability to participate in the study. A second weakness of the design was in the timing of approval to begin the research which coincided with the beginning of the state assessment window. Also, the initial study design included observations and further artifact collection which would have required more time from the teachers and may have limited their capacity to participate.

**Recommendations for Future Research**

Future research should examine the training of administrators and their philosophies and beliefs about content area instruction and scheduling at the elementary level. Also, a study should be conducted of fifth grade teachers who are responsible for a high-stakes assessment and
their perspectives of science instruction at the elementary grade levels. Additionally, a study should be conducted to document the beliefs and strategies of teachers at designated STEM/STEAM LEAs. Additionally, a study about science at the elementary levels in other states should be considered. Another topic would be to research the professional development offerings to teachers in the area of science to identify professional learning to assist teachers in increasing their capacity and self-efficacy as science educators. Finally, research comparing college students who complete STEM career degree programs with the state guidelines for elementary science instruction is recommended.

**Summary**

This study highlighted the shared experiences of elementary teachers who have taught third or fourth grade in the past two to three years who have a passion for science but feel limited in their science instruction. Participants articulated a growth mindset and believe in constructivism and inquiry in the classroom as a means to build student science knowledge. The study recommended that the state clarify science instruction guidelines and provide professional learning on the new MLS standards which lack clarity and organization. Also, the study identified methodologies used to garner more time in an elementary schedule for science instruction. However, the strategies did not result in increased time over the school year in the content as teachers still split the time between science and social studies. It was recommended that administrators and teacher teams recognize science as a core subject and provide daily instruction in the content in grades three and four. Finally, the study revealed that the essence of the phenomenon of being a third or fourth grade elementary teacher, who is passionate about science but feels limited in science instruction is a growth mindset, an attitude of self-reflection,
and a willingness to continually grow and teach themselves because it makes them more effective in the classroom.

Imagine for a moment, a quiet classroom in the early hours of evening and a teacher working alone to teach herself a science concept or put together a science lab for her students the next day. There is a busy quality to the evening as she is researching and putting together the materials students will need the following day. In her mind, she wishes that she could share the ideas with her teammates because there is never time during collaboration to discuss science because they are not preparing students for a state test. She examines her schedule and considers strategies to make a little more time for science instruction while wishing that the principal would come in to observe and help her become a better science teacher. She smiles to herself knowing the reaction of her students is worth the time and effort. This is a picture of the participants in the research study. Missouri elementary teachers want to grow as educators and, even in a culture of high-stakes assessment, welcome accountability to receive feedback and place value on science content. They believe they can impact student achievement through inquiry based science instruction and they are willing to invest time and effort to benefit students.
REFERENCES


Missouri Department of Elementary and Secondary Education. (2013). MSIP 5 resources and standards: Retrieved from
http://dese.mo.gov/sites/default/files/MSIP_5_Resource_and_Process_Standards.pdf


Simsek, P., & Kabapinar, F. (2010). The effects of inquiry-based learning on elementary students’ conceptual understanding of matter, scientific process skills and science


http://www2.ed.gov/nclb/accountability/index.html


APPENDIX A

State Research Permission Inquiry

From: [Redacted]
Date: Thu, Jun 2, 2016 at 12:30 PM
Subject: RE: Question
To: April Williams [Redacted]

You do not have to notify DESE of anything, please remember for data requests (list of 3 and 4 grade teachers in Missouri) use this link:

https://apps.dese.mo.gov/datarquestform/requestform.aspx

Good Luck

From: April Williams [Redacted]
Sent: Thursday, June 02, 2016 12:21 PM
To: [Redacted]
Subject: Question

Hello, I hope things have settled down a little bit for you now that the assessment window has closed.

I have a quick question for you. I am currently working on preparing my prospectus for IRB approval to complete my doctorate. I am wanting to do a study centered on teachers of 3rd and 4th grade in the state of Missouri particularly in regards to the teaching of science. Would I need to apply to anyone at DESE for approval prior to beginning? If so, to whom would I need to address the request?

April Williams

Director of STE+AM Grant
APPENDIX B

Recruitment Email

Hello [name], I hope this email finds you well. I am working on my dissertation and wanted to reach out to you as a current or former 3rd or 4th grade teacher. I am conducting research about the experiences of 3rd and 4th grade teachers who have a passion for science but feel that they have been limited in teaching science by external factors. I am including a link to a smore with more information and access to the documents needed.

Participation is optional and completely confidential. Teachers who have taught 3rd or 4th grade in the past 2 or 3 years are invited to participate. Would you please participate in my study? It will take about 1 to 1 ½ hours of your time. The steps for participation are as follows and detailed on the smore with links to all documents and surveys.

1. Sign and return the Consent Form.
2. Complete the Science Efficacy Survey.
3. Email me a copy of your daily or weekly time schedule for teaching science.
4. Email to set up an interview to be conducted in person, via phone or WebEx.
5. Complete the interview.

Also, would you please share this link with teachers known to you who may be interested in sharing their experiences as a 3rd or 4th grade teacher in Missouri?

https://www.smore.com/yhp6f-calling-missouri-teachers

I appreciate your time and help.

Thank you,

April Williams
APPENDIX C

Social Media Post

Twitter -- @aprildawnnell
Share smore https://www.smore.com/yhp6f-calling-missouri-teachers to twitter with the following hashtags, #Missouri #Science #ScienceTeacher #Elementary #Teachers

Facebook – April Irwin Williams
Please share with Missouri teachers who may be interested in participating in my research study. Share smore https://www.smore.com/yhp6f-calling-missouri-teachers to Facebook.
APPENDIX D

Recruitment Email Administrator

Hello [name], I hope this email finds you well. I am working on my dissertation and wanted to reach out to you as an administrator who works with elementary teachers. I am conducting research about the experiences of 3rd and 4th grade teachers who have a passion for science but feel they are limited in teaching science by external factors. Participation is optional and all participants are kept confidential. I have included a link to a smore inviting teachers to participate in my study. Would you please share this with teachers known to you who may be interested in sharing their experiences as a 3rd or 4th grade teacher in Missouri in the past 2 to 3 years?

https://www.smore.com/yhp6f-calling-missouri-teachers

I appreciate your time and help.
Thank you,

April Williams
APPENDIX E

Participant Consent Form

The Liberty University Institutional Review Board has approved this document for use from 2/16/2017 to 2/15/2018 Protocol # 2728.021617

Participant Consent Form

Science Instruction: A Study into the Curricular Experiences of Missouri Elementary School Teachers
April Williams
Liberty University
School of Education

You are invited to be in a research study of the science teaching experiences of Missouri elementary teachers. You were selected as a possible participant because you are a 3rd or 4th grade teacher who may feel limited by external factors (i.e., high stakes assessment, standards, scheduling etc.) in your science instruction. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

April Williams, a student in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to describe the curricular experiences of teachers who share in the phenomenon of teaching 3rd and 4th grade in Missouri and feel limited in science instruction in their classroom due to external factors.

Procedures: If you agree to be in this study, I would ask you to do the following things:
1) Complete a Science Teacher Efficacy Belief Inventory questionnaire and interview. The questionnaire is accessed via a link in the recruitment email and will take maybe 15-20 minutes to complete. The interview will be set up for a time that is convenient for you and will be conducted in person. The interview question prompts are the same as those on the questionnaire to allow you to expand on your answers, and the interview will be audio-recorded to ensure exact transcription of participant responses. The interview may take 30-45 minutes.
2) Provide the researcher with a copy of your class daily or weekly schedule or type it out and email it to her. It should take approximately 10-15 minutes to gather the requested information and email it.

Risks and Benefits of being in the Study: The risks involved in this study are minimal and no more than a participant might encounter in everyday life with a confidentiality breach being the greatest identified risk. The benefits to society is to add to the body of knowledge the strategies, qualities and characteristics of teachers who are passionate about science instruction in the elementary classroom.

Compensation: Participants will not be compensated for participating in this study.

Confidentiality: Data collection will be confidential and the identities of participants, districts, and buildings will be protected with paper and recorded and digital artifacts secured in locked file cabinet or protected with a secure password. The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be
stored securely, and only the researcher will have access to the records. Recordings, transcriptions, and paper documents will be locked in a file cabinet and digital documents will be maintained with a secured password in my home office. Participants will retain confidentiality as artifacts and information will be coded, and no identifying information will be recorded in the research paper. Recordings will be kept for transcription following the interviews. The information will be used only for educational purposes to complete the research study. All documentation, artifacts, and recordings will be securely destroyed after the three-year data retention time requirements.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

How to Withdraw from the Study: If you choose to withdraw from the study, please contact the researcher at the email address/phone number included in the next paragraph. Should you choose to withdraw, data collected from you, will be destroyed immediately and will not be included in this study.

Contacts and Questions: The researcher conducting this study is April Williams. You may ask any questions you have now. If you have questions later, you are encouraged to contact her at awilliams488@liberty.edu or 660-238-2110. You may also contact the researcher’s faculty advisor, Dr. L. Daniele Bradshaw, at ldbradshaw3@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, you are encouraged to contact the Institutional Review Board, 1971 University Blvd, Green Hall Suite 1887, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information to keep for your records.

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ The researcher has my permission to audio-record me as part of my participation in this study.

Signature: __________________________ Date: __________

Signature of Investigator: __________________________ Date: __________
Dear ___________,

Thank you for returning the consent form and participating in my research. {Would you also please send the [document]??} I wanted to confirm the date, time and method for the interview. I have down that we will meet on [day] at [time]. We will be meeting {by phone, WebEx, or at [location]}. I will call you at [number]. The WebEx link is below. Or I will see you then.}

If any of the above is inaccurate, please contact me at your earliest convenience. I appreciate your time and look forward to talking with you.

Sincerely,

April Williams
APPENDIX G

Teacher Interview Confirmation Phone Call

Hello, may I speak with {Participant}. This is April Williams. How are you today? {Appropriate personal response.} I wanted to take a moment to thank you for participating in my research and for returning the consent form. {I also wanted to ask if you would send me a copy of your class schedule. Thank you.} I am looking forward to our interview. I have down that our interview is on [day] at [time] and we will be meeting {by phone, WebEx, or at [location]}. I will call you at [number]. The WebEx link is below. Or, I will see you then.

If they need to change any details:
{What day, and time would be convenient for you then? Yes, that works for me as well I will see you then. Or, I am sorry I am unavailable would [day] at [time] work for you?}

Sincerely,

April Williams
APPENDIX H

IRB Approval

February 16, 2017

April Williams
IRB Approval 2728.021617: Science Instruction in a Culture of High-Stakes Assessment: A Transcendental Phenomenological Study into the Experiences of Missouri Elementary School Teachers in a Non-Assessed Grade Level

Dear April Williams,

We are pleased to inform you that your study has been approved by the Liberty University IRB. This approval is extended to you for one year from the date provided above with your protocol number. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

[Signature]

Administrative Chair of Institutional Research
The Graduate School

Liberty University | Training Champions for Christ since 1971
APPENDIX I

Instruments STEBI-A

Science Teaching Efficacy Belief Instrument*

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>A</td>
<td>Agree</td>
</tr>
<tr>
<td>UN</td>
<td>Uncertain</td>
</tr>
<tr>
<td>D</td>
<td>Disagree</td>
</tr>
<tr>
<td>SD</td>
<td>Strongly Disagree</td>
</tr>
</tbody>
</table>

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.  
2. I am continually finding better ways to teach science.  
3. Even when I try very hard, I don't teach science as well as I do most subjects.  
4. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.  
5. I know the steps necessary to teach science concepts effectively.  
6. I am not very effective in monitoring science experiments.  
7. If students are underachieving in science, it is most likely due to ineffective science teaching.  
8. I generally teach science ineffectively.  
9. The inadequacy of a student's science background can be overcome by good teaching.  
10. The low science achievement of some students cannot generally be blamed on their teachers.  
11. When a low achieving child progresses in science, it is usually due to extra attention given by the teacher.  
12. I understand science concepts well enough to be effective in teaching elementary science.  
13. Increased effort in science teaching produces little change in some students' science achievement.  
14. The teacher is generally responsible for the achievement of students in science.  
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.  
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.  
17. I find it difficult to explain to students why science experiments work.  
18. I am typically able to answer students' science questions.  
19. I wonder if I have the necessary skills to teach science.  
20. Effectiveness in science teaching has little influence on the achievement of students with low motivation.  
21. Given a choice, I would not invite the principal to evaluate my science teaching.  
22. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.  
23. When teaching science, I usually welcome student questions.  
24. I don't know what to do to turn students on to science.  
25. Even teachers with good science teaching abilities cannot help some kids learn science.

Re: STEBI-A permission Request

Re: STEBI-A permission Request

IR  6/23/2016
Williams, April Dawn-Nell

Hello April,

The STEBI is not copyrighted. You are welcome to use it. Best wishes for your study!

From: Williams, April Dawn-Nell <awilliams48@liberty.edu>
Sent: Tuesday, June 28, 2016 8:44 AM
To:
Subject: STEBI-A permission Request

I am sending this permission request via email and regular mail for your consideration.

Thank you in advance for your time, please let me know if you have any questions or require further information to make a decision about this educational study.

Sincerely,
April Williams
June 28, 2016

Dear Professor Riggs,

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctoral degree. I am currently in the development process of the dissertation proposal. The title of my research project is Science instruction in a culture of high-stakes assessment: A transcendental phenomenological study into the experiences of Missouri elementary school teachers in a non-assessed grade level. The purpose of my research is to identify the characteristics and beliefs of teachers who are not accountable for science on state assessment but chose to incorporate science on a daily basis.

I am writing to request your permission to utilize the Science Teacher Efficacy Belief Instrument (STEBI-A) for in-service teachers in my research.

Participants will be asked to complete the STEBI-A. The data will be used to identify similar beliefs of teachers who implement science daily in a grade level that is not assessed on the content material with state assessments but are accountable to state assessments in other content areas. Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission, please respond by email to awilliams488@ liberty.edu or by mail to the address below.

Sincerely,

April D-N. Williams
Graduate Student
Dear [Recipient]:

I wanted to take a moment to thank you for participating in my dissertation research. I appreciate your participation and the time you spent assisting in this project.

Sincerely,

April Williams
Graduate Student
APPENDIX L

External Auditor Confidentiality Statement

Confidentiality Statement

Study Title: Science Instruction in a Culture of High-Stakes Assessment: A Transcendental Phenomenological Study into the Experiences of Missouri Elementary School Teachers in a Non-Assessed Grade Level

Researcher: April Williams

As a member of the research team, I have been made aware of and agree to maintain confidentiality throughout the research process.

- I agree to maintain anonymity for research participants and locations of which I may become aware.
- I agree to maintain confidentiality for research participants if any sensitive information regarding sexual preferences, classroom effectiveness or any information which may lead to discrimination in the school setting becomes known to me.
- I agree to keep confidentiality by not using coding when discussing research with research team members.
- I agree to maintain confidentiality by not discussing information which can be connected with a participant or location with individuals who are not authorized members of the research team.

[Signatures and dates]

External Auditor Signature

[Redacted]

Date: 10-28-16

Researcher Signature

[Redacted]

Date: 11/14/16