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Science in the School Library Inquiry Model (SSLIM): A Mixed-Methods Case Study of the Implementation of a Science and Information Inquiry Curriculum in an Elementary Library

by

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ABSTRACT

Science in the School Library Inquiry Model (SSLIM): A Mixed-Methods Case Study of the Implementation of a Science and Information Inquiry Curriculum in an Elementary Library

Bree L. Ruzzi
Old Dominion University, 2019
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Data indicate that students in the U.S. may start school with lower levels of science understanding and that these levels may consistently remain lower throughout their public-school career. With deficits in science achievement starting in the earliest years of students' education, benefits may be gained by exploring alternate resources and alternative environments that can support young student's science education and achievement. A largely unexplored area for science instruction is in the school library. This dissertation, a mixed-methods, case study, examined the creation and implementation of a novel information and science inquiry model and curriculum, SSLIM. This curriculum was created and implemented by one school librarian and the researcher with second-grade students. The school librarian and the researcher collaboratively designed and implemented six scientific and library inquiry lessons over six 45-minute class periods. Following an examination of the commonalities between national library and science standards and inquiry cycles, the researcher posits that the library may be an optimal space in the school for the complete scientific inquiry process including both textual and experiential investigations. Analysis included the stages of collaboration through this creation process, changes in librarian efficacy beliefs in teaching science as well as changes in student ideas about who can do science and student perceptions about the nature of science and scientific inquiry. Data collection included recordings of planning sessions conducted by the researcher and school librarian, journals maintained by the school librarian and the researcher, the Science Teacher Efficacy Belief Instrument (STEBI-B), a librarian and researcher designed science inquiry content test, the Draw-A-Scientist Test (DAST), and an abbreviated version of the Young Children's Views of Science (YCVS) instrument.

Results from this study indicate that extensive amounts of time and resources are necessary to build this type of curriculum. While the development of the curriculum did not have any measurable effects on the school librarian's feelings or efficacy in teaching science, the science inquiry content test and the YCVS measures showed a statistically significant increase in mean student scores at the time of posttest. Additionally, female students drew significantly more diverse images of scientists on the DAST at the time of posttest.

Dedication

This thesis is dedicated to so many people. First and foremost, to my husband and children who unreservedly loved, supported, and lifted me up through this process, even on the darkest days. To my brother and sister-in-law who cared for me and my family when I felt too tired to do so myself. To my in-laws who continually checked in with me and supported me unconditionally. To my uncle, who never missed an opportunity to tell me he was proud of me. To many friends at ODU, but especially to Angie for being my work-wife and confidante for so many years; to Becca for keeping me on track, for *countless* hours of talking and proof reading, and for finishing this process with me (literally) side-by-side; to Stephanie who has been my travel companion and good friend, and who has listened and talked me off the cliff more times than I can count. Finally, to Barbara "Babs" for being my mama duck and taking me under her wing on my very first day at ODU when I broke the freezer in the doc office. I would also like to acknowledge all of the friends and family who listened to me cry and complain, ad nauseam, over the last five years. But this thesis is especially dedicated to my mother and father. To my mother who never once faltered in her belief in me with constant support of every kind imaginable. Your intelligence, strength, and determination in life has been a model I have aspired to live up to. And to my father who passed away in my first semester of this journey. He was the first PhD in my family, and he encouraged me to pursue this degree. He would have told me I had worked way too hard on this. I love you Dad and I think you'd be right.

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Everyone knows it “takes a village” to write a dissertation. I decided early on in my research that I wanted my village to consist of people who not only influenced who I had become as a scholar, but people I would choose to be friends with (given the opportunity) outside of academia. People who were simultaneously brilliant, kind, funny, and supportive. It is rare to find this combination in a single person, however, I was lucky enough to find it in multiple individuals. The women who formed my committee are the epitome of intelligence coupled with patience and compassion and finished with exemplary pedagogy. I truly could not have written this without them. Thank you to Angela for reigniting my love of teaching young children, to Shana for introducing me to my affinity for statistics (and then guiding me through the processes again when I forgot), and to Marcia who is the guru of science and school libraries. Additionally, I would like to thank Gail Dickinson for all of your help and support throughout the years, as well as express my gratitude to all of the amazing ODU professors with whom I have had the pleasure of learning from. I thank you all for helping me through this process. But I especially thank Sue Kimmel as my chair, cheerleader, confidant, and advisor. I could not have asked for a better mentor and friend. You thought the most of me, even when I was not at my finest. You were unconditionally positive and supportive, but pulled me back down to earth when I needed it. You are truly the best of the best and I cannot imagine trying to complete a paper of this magnitude with anyone else. Thank you.

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CHAPTER 1

INTRODUCTION

There are shocking deficits in US science achievement. According to the 2016 ACT scores, 64% percent of tested high school seniors failed to meet science readiness benchmarks, with science scoring the lowest of all tested content areas (ACT, 2016). According to the most recent *Nation's Report Card* (2015), 66% of eighth graders, and 62% of fourth-graders failed to reach *Proficient* achievement in science (National Assessment of Educational Progress, 2019). In a recent national longitudinal study, the *Early Childhood Longitudinal Study (ECLS: 2011),* data reports showed that students entered first grade with science as the lowest scoring of the tested subjects, and that science scores remained the lowest scoring tested subject through fourth grade (Mulligan, McCarroll, Flanagan, & Potter, 2014; 2015; 2016; 2018). This indicates that students may start school with lower levels of science understanding and that these levels may consistently remain lower throughout their public-school career. This continual lack of science achievement in our public school is troubling. "[T]he U.S. system of science and mathematics education is performing far below par and, if left unattended, will leave millions of young Americans unprepared to succeed in a global economy" (NGSS Lead States, 2013, The Need for Standards, para 1).

With deficits in science achievement starting in the earliest years of students' education, benefits may be gained by exploring alternate resources and alternative environments which can support young student's science education and achievement. A largely unexplored area for science instruction is in the school library. While the school library and science have historically shown a disconnect (Mardis, 2007) there are numerous similarities between science and library standards which, if integrated, may support both subjects. Additionally, both library instruction and science education utilize inquiry cycles with multiple common components. This indicates that the school librarian may already be a present, yet untapped, educational resources to supporting science instruction. A novel curriculum which blends the similar standards and inquiry cycles of science and library instruction could provide supports needed in additional science instruction in the elementary school, while also supporting information literacy skills mandated by national school library standards.

In the research study that follows, I present the development of a science and library hybrid curriculum which supports both national science standards and national school library standards. Additionally, I present a new inquiry cycle, analyzation of the collaborative creation process, and the results from student and librarian measures. In this research I look at the effects this curriculum may have had on increased student scores through three measurements, as well as the effects the development and implementation had on the school librarian and her feelings about science.

Problem Statements

In various national measures and across grade levels, science achievement is falling behind other tested subjects. Students in the United States ranked 25th globally out of 70 countries on PISA (2015) science achievement (OECD, 2019). In 2016, 64% percent of tested high school seniors did not meet college readiness benchmarks in science (ACT, 2016). According to the *Nation's Report Card* (2015), 66% of students in eighth-grade students failed to meet *Proficient* levels of science achievement, with 32% failing to meet *Basic* levels of science achievement (National Assessment of Educational Progress, 2019). With these statistics in mind, it is somewhat unsurprising that the most recent reports indicate that over half of United States patents are being filed by foreign competitors (US Patent and Trademark Office, 2019).

In addition to the aforementioned statistics, research indicates that the lack of student achievement in science begins much earlier than eighth grade. Similar deficits were found on fourth grade science scores according to our *Nation's Report Card* (2015), to only a slightly lesser degree, with 62% of fourth graders failing to reach *Proficient* levels of achievement in science and 24% of those students failing to meet *Basic* levels of achievement in science (National Assessment of Educational Progress, 2019). This lag in science achievement may begin even earlier. *The National Center for Educational Statistics' Early Childhood Longitudinal Study (ECLS: 2011)*, followed a cohort of over 18,000 students nationwide from their entrance into kindergarten through fifth grade. The preliminary results indicate that in the early childhood classroom, science is the lowest scoring tested subject when compared to language arts test scores and mathematic test scores. While science was not tested in the kindergarten setting, the results from the first, second, third, and fourth-grade tests indicate that science is the lowest scoring tested subject for every grade level. Meaning, students entered first grade with lower science scores than those of language arts and mathematics and exited fourth grade with lower science scores than language arts and mathematics scores (Mulligan, McCarroll, Flanagan, & Potter, 2014; 2015; 2016; 2018). This may indicate that science instruction has taken a backseat to reading, writing, and mathematics in the early childhood classroom. This may also be occurring during a period when young children are hailed as "natural scientists" (NAEYC, 2019b) for their innate dispositions toward investigation and inquiry.

These shortcomings in elementary science education may be the basis for lower student attitudes about science and lower science scores in middle and high school, as it is commonly accepted that students have formed concrete ideas about science and who does science by the time they exit elementary school (Archer, Dewitt, Osborne, Dillon, Willis & Wong, 2010; Murphy & Beggs, 2005). In addition, it is during the elementary school years that students' overall positive feelings about science may start to change to negative feelings about science (Murphy & Beggs, 2003). There may be several reasons why science education is being marginalized. Research indicates that science instruction may be pushed to the side to offer more time to focus on tested subjects such as language arts and mathematics (Griffith & Scharmann, 2008) and that some teachers report not even being asked by administration about non-tested subjects such as science (Patrick, Mantzicopoulos, & Samarapungavan, 2008). In addition, general education teachers, such as those found in the elementary school, have reported lower levels of comfort when teaching science (Appleton, 2003; Rawson, Anderson, & Hughes-Hassell, 2015).

However, there is an area in the elementary school that may be in the position to support elementary science instruction, but may be largely overlooked: the school library. National school library standards and national science education standards are similar in many areas. School library instruction and science education also share commonalities in accepted inquiry cycles in each respective field. Additionally, school librarians are educated to support all content areas within the school. "Qualified school librarians have been educated and certified to perform interlinked, interdisciplinary, and cross-cutting roles as instructional leaders, program administrators, educators, collaborative partners, and information specialists" (AASL Standards Framework for Learners, 2018, Common Beliefs). And while research indicates that the presence of a certified school librarian correlates to higher achievement in language arts test scores (Lance, 1994; Rodney, Lance, & Hamilton-Pennell, 2003; Scholastic, 2016), there is little research present about those correlations to other tested subjects such as science (Mardis, 2007;

Subramanian, 2015). However, commonalities between these two subjects suggest that the school librarian may be in a position to blend science education with library instruction in a way that supports student learning in both areas. Additionally, the school library may be an alternative environment within the school for experiential scientific inquiry.

The school librarian is trained to assist students in locating and selecting materials appropriate for their personal and research interests, and the school library is an environment within the elementary school where students are encouraged to “Express[ing] curiosity about a topic of personal interest or curricular relevance” (AASL Standards Framework for Learners, 2018, C.V.1) and “Engage[ing] in inquiry-based processes for personal growth” (AASL Standards Framework for Learners, 2018, A.V.3.). What is still unknown is how these same ideals could be applied to support science inquiry, and what science instruction in the library might look like. Furthermore, how might a hybrid library and science curriculum impact student knowledge of science, or achievement on science measures? While there have been calls for more research with science in the library (Mardis, 2007; Subramanian, 2015), little empirical research is present on the effects these lessons have on student achievement in science and no research could be located which quantified student test results. These student-driven, learner-centered components are the cornerstone to the research that follows.

Purpose

The purpose of this mixed-method, case study research was to explore the development of a science and information inquiry curriculum that leveraged the synergies between science and library instruction. Through this curriculum the school librarian and I worked together. We supported second-grade student science learning in the areas of nature of science, scientific inquiry, and the diversity of science and scientists, while simultaneously supporting information literacy through inquiry. I also examined the effects this curriculum development had on the school librarian’s efficacy and feelings about teaching science. We collected the quantitative data in this study through three student measures: The Draw-A-Scientist Test (Chambers,1983), the Young Children’s Views of Science (Lederman, Bartels, Lederman, & Gnanakkan, 2014) protocol, and a science inquiry content test, as well as through one librarian measure, the Science Teacher Efficacy Belief Instrument (STEBI-B) (Riggs, & Enochs, 1990). I collected qualitative data through nine collaborative planning sessions and librarian and researcher journals. I utilized these data sources in the development of the curriculum, and I was guided by the following research questions:

Research Questions

1) How do an elementary school librarian and an educational researcher, collaboratively plan and implement a learner-centered information and science inquiry curriculum for second-grade students in the school library?
2) How does the development and implementation of this curriculum affect the school librarian’s feelings and self-efficacy of teaching science?
3) How do students’ science content knowledge, perceptions about nature of science and scientific inquiry, and ideas about who does science change through information and scientific inquiry lessons in the school library?

I utilized the constructivist theory as a foundation to the develop, implement, and establish student goals for these lessons. I developed the lessons explicitly with the learner-centered ideology as the backbone of each lesson. Additionally, I explored self-efficacy as it relates to the school librarian’s feeling about teaching science. The theoretical frameworks and ideology I utilized in the design of this research study follow.

Theoretical Frameworks

Constructivism

A main objective of my research was to examine how young students make sense of and develop their ideas of nature of science (NOS) and scientific inquiry (SI) through individual interest-driven inquiry during library instructional times. The National Science Teachers Association (NSTA), identifies the nature of science as “characterized by the systematic gathering of information through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. The principal product of science is knowledge in the form of naturalistic concepts and the laws and theories related to those concepts” (NSTA, 2000, Preamble). The *Next Generation Science Standards* define scientific inquiry as the “formulation of a question that can be answered through investigation…” (NGSS Lead States, 2013, Dimension 1). The foundation of these lessons is framed by the learner-centered ideology, where students have agency in deciding what they choose to learn about (Schiro, 2013). This ideology is based directly on the constructivist theory where students learn at individual rates through varied social experiences within the learning environment. Through this design, students learn at their own pace and within their own personal Zone of Proximal Development (ZPD). Vygotsky (1978) identifies the ZPD as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers” (p. 86). Vygotsky identified the constructivist environment as the optimal environment for children to advance to the next level of learning. Similarly, Montessori (1995) advocated for environments where children were given the opportunity to work together cooperatively or independently to discover their own individual intrinsic desire to learn at their own pace and about their areas of interests. I utilized these learner-centered, constructivist frameworks as the foundation of the study and to develop of all science lessons, the learning environment, and student choices made available within the lessons.

Self-efficacy

One suggested reason for the lack of science education in the elementary school is that some classroom teachers feeling unsure about science and teaching science (Appleton, 2003; Rawson, Anderson, & Hughes-Hassell, 2015). This is not limited to the classroom teacher but can also be true of school librarians (Mardis, 2007; Schultz-Jones & Ledbetter, 2009; Rawson, Anderson, & Hughes-Hassell, 2015). These feelings of unsureness (or alternately self-assuredness) of their teaching beliefs, can be identified as the teacher's self-efficacy (Bandura, 1977) and may influence the ways that they teach or avoid teaching certain subjects. "The task of creating learning environments conducive to development of cognitive skills rests heavily on the talents and self-efficacy of teachers" (Bandura, 1993, p. 140). Since school librarians are certified, generalist teachers it stands to reason that this may also affect the school librarian when planning and teaching lessons with science components. As a result, self-efficacy was measured using the Science Teacher Efficacy Belief Instrument (STEBI-B) (Riggs, & Enochs, 1990), which was designed for general education elementary classroom teachers. Librarian journals were also utilized to give a broader picture of the effects of the lessons on the school librarian's feelings about teaching science.

Methods

In this research, I employed a variety of measures to answer the research questions for both the students and the librarian. I utilized a mixed-methods approach to address qualitative and quantitative aspects of the case study as well as examined results from both the librarian and the students. I determined case study was the most appropriate method because it is an "empirical inquiry that investigates a contemporary phenomenon (the "case") in depth and within a real-world context, especially when the boundaries between phenomenon and context may not be clearly evident" (Yin, 2014, p. 16). Through this research methodology, I was able to present a more comprehensive picture of what one certified school librarian and her students encountered when she and I, as participant-researcher, planned and implemented novel library and science inquiry lessons during scheduled library instructional times.

I gathered data before planning began and until after the completion of all the student inquiry lessons. This process began when I administered the Science Teacher Efficacy Belief Instrument (STEBI-B) (Riggs, & Enochs, 1990) to the school librarian, before any science lesson planning began. I also asked her to keep a daily journal after each inquiry lesson, starting with the pretests. We then collaboratively administered the Draw-A-Scientist Test (DAST) (Chambers, 1983) to the students. Once science lesson planning began, the school librarian and I developed and administered the science inquiry content pre-test to establish a student baseline of science knowledge on the topics that were to be covered in the inquiry lessons. We also divided students into small groups and administered an abbreviated version of the Young Children's Views of Science (YCVS) (Lederman, Bartels, Lederman, & Gnanakkan, 2014). We administered all pretests over two weeks of library instructional times, which were interwoven with literature instruction about science and scientists. During these pretesting weeks, the school librarian and I began collaborative planning to construct the information and science inquiry lessons for future library instructional times. I recorded and transcribed these planning sessions which serve as the primary data source for understanding the changes in phases of collaboration over time when implementing this novel science curriculum. We implemented the collaboratively created lessons for six instructional weeks. I was an active participant-researcher in all planning, and in the implementation of all lessons. During this time, I also journaled daily, reporting my own perceptions about the collaborations, perceived successes and failures, librarian comments, and student comments and work that occurred during both the planning sessions and lesson implementations. Finally, we re-administered all pretest measures after completion of the science inquiry lessons, as a means of posttesting.

I utilized paired sample *t* tests to quantitatively analyze any changes in student mean scores for whole sample and then used independent sample *t* tests to determine any changes based on gender. Similarly, I analyzed the STEBI-B results using a paired sample *t* test to measure any change of answers of the entire instrument, then by independent sample *t* test to examine efficacy belief and outcome expectancy as separate measures. I began qualitative data analysis with open coding of the school librarian’s journal and my own daily journal. I revised and condensed these codes multiple times throughout the coding process. I applied deductive coding of collaborative phases (Kimmel, 2012), to the transcripts of our nine collaborative planning sessions. I compared collaborative data and journal data after coding and analysis was complete, to establish overarching themes.   All statistical data analyses and qualitative coding were verified by an external review committee of two educational researchers.

Procedures

Because the school library is inherently a learner-centered environment, and due to the wealth of information presented in the school library, I considered at the elementary school library an optimal place to conduct inquiry investigations utilizing information literacy skills blended with science instruction. Additionally, the school librarian was a certified teacher within the school and had the knowledge and resources to implement this type of novel instruction. The school librarian and I developed the curriculum in this research study to allow the students to simultaneously conduct textual research and physical investigations and fluidly move between these sources of information, as needed. We also designed it to allow the students to choose their own personally created area of inquiry and allow them to move at their own pace through a research process based on their own individual research interests.

Through librarian and researcher developed science and library inquiry lessons, which were primarily conducted and carried out in the school library, I aspire to present the reader with a comprehensive case study which examines science instruction within the school library setting. Through this research I examine the school librarian as a resource for teaching a novel information and science inquiry curriculum. I in no way suggest that the school librarian should be a replacement for science instruction in the classroom, or as the sole science instructor in the school. To the contrary, some of the students in this research continued to receive science instruction in the classroom simultaneously with the research study. However, I do suggest that the school librarian is a powerful, sometimes unacknowledged educator, who can support various curricula within the school, as well as impact student achievement in a variety of content areas.

While research has been conducted on the teacher and librarian effects of the implementation of collaborative science lessons (Montiel-Overall, & Grimes, 2013), little has been researched on the effects these lessons have on the students' science comprehension. No research has been conducted on school librarians implementing science content lessons while functioning in a fixed schedule, with little to no common planning time or collaboration with classroom teachers. This research seeks to address that gap in the research literature.

Limitations

My personal involvement was a large limitation in this research, as it inevitably influenced my data collection and possibly data analysis. In addition, this was a small study which only involved one librarian and a small student sample from one grade level, in one school, in one school system. Therefore, the results from this study cannot be generalized to the greater population, other grade levels, to other subjects, or other schools or libraries. However, it was my intent to intensely examine this small sample to gain insight into the intricacies of the challenges, processes, thoughts, ideas, and reactions of the students and the librarian involved. This small sample permitted me to utilize a mixed methods case study methodology, which allowed for both quantitative and qualitative measures to be collected and provided insight into multiple aspects of the research and the participants.

Delimitations

I selected the school system because it represented a population of students from a variety of socio-economic and cultural backgrounds. I chose the school librarian through extensive discussion with the district-wide school library administrator, in order to identify a school librarian that actively wanted to participate in this study. I chose a library with a fixed schedule to represent a population of school libraries and librarians that are underrepresented in the research. This was also an important factor in my examination of the changes in student and librarian perceptions while utilizing short, regularly scheduled, instructional periods in the school library. I chose second grade, because it is representative of the early childhood classroom, but at the upper age range. I chose this higher early childhood grade in an effort to collect more in-depth data from the students due to the longer experience in elementary school and higher levels of verbal, reading, and writing abilities, as compared to younger students. In addition, it represented an age where students may or may not have formed firm opinions about science. Finally, I utilized the data from all students that returned consent forms and gave personal assent in the research in an effort to utilize the broadest pool of data available.

Conclusion

The purpose of this research was to explore how a school librarian and researcher planned and implemented an information and science inquiry curriculum into library instructional times, to support student science instruction. In the following chapters, I will present how the development and implementation of this curriculum affected the school librarian's efficacy in teaching science, as well as how inquiry lessons may have influenced changes in student scores about nature of science, scientific inquiry, and the diversity of science and scientists through three measure. In the following chapters I will present how a mutually beneficial library and science curriculum was developed and implemented in one elementary school fixed-library schedule. I will present the way one school librarian and an educational researcher addressed and supported information and science inquiry, and the effects this had on student science learning. Through this research, I aspire to inform librarians and other educators on the ever-changing role of the school librarian. I hope that through this research, educators will see the possibilities of re-envisioning the role of the school librarian and of the school library to support the diverse educational needs in the elementary school and its corresponding curricula. With students as a target and active population of this study, I hope to show how this type of innovative instruction can influence student perceptions and support various school curricula. In chapter 2 I will address the similarities between national library standards and national science standards, similarities in the respective inquiry models, similarities in the declines of both areas in the educational environment, and a provide a more thorough look at the theoretical frameworks and ideologies utilized to develop this research study.

Working Definitions

Though certain terms can be operationally defined in a variety of ways and vary within disciplines, for the purpose of this research I limited the definitions to the most relevant meaning as it pertains to teaching and working within a school setting, as defined by the experts in that field.

Collaboration - “Collaboration is a trusting, working relationship between two or more equal participants involved in shared thinking, shared planning and shared creation of integrated instruction.” (Montiel-Overall, 2005, p.5).

Early Childhood- “…all young children, birth through age 8” (NAEYC, 2019a, About Us).

Fixed Library Schedule - “…type of scheduling for classes and other activities for the library media center [using] previously specified times …” (U.S. Census Bureau, 2011, p. 4).

Flexible Library Schedule - “…type of scheduling for classes and other activities for the library media center [which are] available as needed…” (U.S. Census Bureau, 2011, p. 4).

Nature of Science (NOS) - “Science is characterized by the systematic gathering of information through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. The principal product of science is knowledge in the form of naturalistic concepts and the laws and theories related to those concepts” (NSTA, 2000, Preamble).

Scientific Inquiry (SI) - “…scientific inquiry involves the formulation of a question that can be answered through investigation…” (NGSS Lead States, 2013, Dimension 1).

Self-efficacy- “People’s beliefs about their capabilities to exercise control over their own level of functioning” (Bandura, 1993, p.118).

Three-Dimensional Science - “…the use of science and engineering practices to actively engage students in science learning, the integration of these practices with disciplinary core ideas and crosscutting concepts, and student learning to be driven by the need to explain phenomena and/or design solutions to problems.” (National Science Teachers Association, 2018, Position Statement)

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter is dedicated to examining the literature and research of information literacy (school library) instruction and science instruction, as well as similarities in each discipline. The chapter begins with an exploration of the similarities in the national standards for both school libraries and science education, which is then followed by common inquiry cycles that each discipline uses, the research involving the two disciplines, and problems they both face in the current educational system. Additionally, I will present the theoretical frameworks and ideology that guided the formation of this research study. Finally, I will present a brief overview of how the sum of these components led to the development of a novel science and library curriculum which supports student learning in both disciplines and was developed and used in this research study.

Commonalities

Common National Standards

There are national standards for both school librarians and for science educators. Each set of standards is distinct to its own discipline, however, there are common themes and terminology used in both. In the next section, I will briefly summarize each set of standards, which will be followed by a comparison of these commonalities.

Next Generation Science Standards. The *Next Generation Science Standards* (NGSS) are the national standards for K-12 science learning. They were developed in 2013 in response to the need for an updated set of science standards (NGSS Lead States, 2013) and were built from the National Research Council’s *A Framework for Science Education: Practices, Crosscutting Concepts and Core Ideas K-12* (National Research Council, 2012). Within these standards, there are three main “dimensions”: *Science and Engineering Practices, Crosscutting Concepts*, and *Disciplinary Core Ideas*. These are “distinct and equally important dimensions to learning science” (NGSS Lead States, 2013, para. 1). Disciplinary Core Ideas are the main (core) ideas of the each of the four domains of science (Physical Sciences, the Life Sciences, Earth and Space Sciences, and Engineering, Technology, and Applications of Science) and are considered the main focal points of that science. Crosscutting Concepts are concepts seen across each of the four domains of science. These are concepts such as patterns, cause and effect, and structure and function, to name a few. Science and Engineering Practices (henceforth called *Practices*) “better explain and extend what is meant by “inquiry” in science and the range of cognitive, social, and physical practices that it requires” (NGSS Lead States, 2013, Science and Engineering Practices). Because the Practices explicitly address the “inquiry” portion of science learning, they were the foundation of the comparison that follows. Additionally, because this research focuses on early childhood science, I limited the Practices to K-2 student expectations.

National School Library Standards. The American Association of School Librarians (AASL) has three sets of frameworks which are included in the *AASL Integrated Standards Framework* (American Association of School Librarians, 2018a). These standards present frameworks for Learners, School Librarians, and School Libraries. Because the Practices used from the *Next Generation Science Standards* are written for student expectations, I utilized the *AASL Standards Framework for Learners* (American Association of School Librarians, 2018b). These student (*Learner*) standards are organized by six *Shared Foundations*. These Shared Foundations are: *Inquire*, *Include*, *Collaborate*, *Curate*, *Explore*, and *Engage*. Within the framework, these Shared Foundations are further explained by learner *Competencies*. Competencies function as individual learning standards and are organized by four *Domains*.

These Domains are: *Think*, *Create*, *Share*, and *Grow*. In the comparison below, I will primarily utilize the individual Competencies as the main source for comparison, however, occasionally Shared Foundations are included for clarification.

In the following section, I will compare the national standards in each discipline. While there is no current crosswalk of AASL Learner Standards and NGSS Practices, there have been library and science crosswalks in the past. The crosswalk developed by Subramaniam, Ahn, Waugh, Taylor, Druin, Fleischmann and Walsh (2013) utilized the *Framework for K–12 Science Education* (National Research Council, 2012) and the *Standards for the 21st Century Learner* (American Library Association, 2010b) to crosswalk the science framework and the previous American Association of School Librarians (AASL) Standards. This was followed by the *Correlations between the AASL Standards for the 21st-Century Learner and the Next Generation Science Standards* (American Association of School Librarians, 2015) which cross-walked the previous AASL standards and the current *Next Generation Science Standards* (NGSS) curriculum. However, since there are no crosswalks utilizing both the new AASL *National School Library Standards for Learners* (American Association of School Librarians, 2018a) and the *Next Generation Science Standards* (NGSS Lead States, 2013). I have identified the common themes and dispositions presented in the *AASL Standards Framework for Learners* (American Association of School Librarians, 2018b) and the K-2 *Next Generation Science Standards: Science and Engineering Practices* (NGSS Lead States, 2013). The following table (Table 1) examines these similarities of the national library standards and the national science standards, but only intends to serve as a comparison, not a comprehensive crosswalk.

Table 1

Comparison of AASL and NGSS Standards

AASL Learner Competencies	NGSS Practices
I. *INQUIRE*…identifying problems, and developing strategies for solving problems	1-LS1-1: solves a specific problem or a solution to a specific problem.
I.A.1: Formulating questions about a personal interest or a curricular topic.	K-2-ETS1-1: Ask questions based on observations to find more information about the natural and/or designed world(s).
I.A.2: Recalling prior and background knowledge as context for new meaning.	*Asking questions and defining problems*…builds on prior experiences and progresses to simple descriptive questions that can be tested.
I.B.1: Using evidence to investigate questions.	*Constructing explanations and designing solutions*… use of evidence and ideas in constructing evidence-based accounts…
I.B.2: Devising and implementing a plan to fill knowledge gaps	1-PS4-1, 1-PS4-3: Plan and conduct investigations collaboratively to produce evidence to answer a question
I.B.3: Generating products that illustrate learning.	*Modeling* … using and developing models that represent concrete events or design solutions
I.C: Learners adapt, communicate, and exchange learning products with others…	K-ESS3-3: Communicate solutions with others in oral and/or written forms using models and/or drawings…
I.C.4: Sharing products with an authentic audience	K-ESS3-3: Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas.
I.D.2: Engaging in sustained inquiry.	2-ESS2-1 Compare multiple solutions to a problem.
I.D.3: Enacting new understanding through real-world connections.	2-ESS1-1 Make observations from several sources to construct an evidence-based account for natural phenomena.
II.C.1. Engaging in informed conversation and active debate	K-ESS2-2, 2-PS1-4: Construct an argument with evidence to support a claim.
III. *COLLABORATE* Work effectively with others to broaden perspectives and work toward common goals.	2-PS1-1, 2-LS2-1: Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. 2-PS1-1, 2-LS2-1
III.B.2 Establishing connections with other learners to build on their own prior knowledge and create new knowledge	*Engaging in argument*…builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).
IV.B/IV.B.1: Learners gather information appropriate to the task by: 1. Seeking a variety of sources.	2-ESS2-3: Obtain information using various texts, … and other media that will be useful in answering a scientific question
V.A.1: Reading widely and deeply in multiple formats	K-ESS3-2: Read grade-appropriate texts and/or use media…
V.B/V.B.1 Learners construct new knowledge by: 1. Problem solving through cycles of design	*Planning and carrying out investigations* to answer questions or test solutions to problems…
V.C.2: Co-constructing innovative means of investigation.	1-PS4-1, 1-PS4-3: Plan and conduct investigations collaboratively to produce evidence to answer a question.

V.C.3: Collaboratively identifying innovative solutions to a challenge or problem.	1-LS1-1: Use materials to design a device that solves a specific problem or a solution to a specific problem.

In most instances in Table 1, I used Learner Competencies (AASL) and student Practices (NGSS) for reference in the comparison. However, occasionally learner Shared Foundations overviews (AASL) and Practices overviews (NGSS) were used for comparison. These are denoted by the use of italics, versus the letter/number combinations of the standards. For example, the first entry in the AASL column is "I. *INQUIRE*…identifying problems and developing strategies for solving problems." This comes from the overview of the first Shared Foundation from the AASL standards, explaining the purpose of the *Inquire* foundation. Similarly, the third entry under the NGSS standards "*Asking questions and defining problems*…builds on prior experiences and progresses to simple descriptive questions that can be tested." comes from the overview of the NGSS Practice *Asking Questions and Defining Problems*. As can be seen, not all domains and competencies are equally represented from the AASL Standards, with the majority of commonalities with NGSS Practices found in the *Inquire* Shared Foundation.

It should also be noted that while some Shared Foundations and/or Competencies matched up very similarly to the NGSS Practice, others required interpretation of the different standards. For example, the first comparison "I. *INQUIRE*…identifying problems, and developing strategies for solving problems" is very similar to the NGSS standard "1-LS1-1: solves a specific problem or a solution to a specific problem." Other comparisons within the table may require further explanation. For example (AASL) "I.B.3: Generating products that illustrate learning" is compared to (NGSS) "*Modeling* … using and developing models that represent concrete events or design solutions." In this case, I focused on the production of different, but similar, products in both disciplines that demonstrate student learning. For library inquiry, this may look like a presentation, a report, or another student-created product. However, in science, the use of models is so important that an entire Practice is dedicated to the creation of models to demonstrate learning, the “learning” is implied, and the model is the product generated. In this way, several standards are compared for their meaning, versus the similarity in the wording.

While each set of national standards show numerous similarities, this is only one of several instances where science and the library naturally dovetail. Parallels can be seen in another crucial area of both library and science instruction: the use of inquiry cycles. In the following section I examine two commonly accepted inquiry cycles, one from each discipline.

Common Inquiry Models

Proposed Methods of Inquiry

As aforementioned, in addition to common standards and guidelines, both science and library science have accepted inquiry models for K-12 students. In the following section I will explore two widely accepted models of inquiry, one from each discipline. These separate, yet similar models informed my research by highlighting common processes and procedures in the inquiry process which, similarly to the national standards, also naturally dovetail. These natural overlaps provided the inspiration to combine the two inquiry models into one comprehensive science and library science inquiry model.

Inquiry Model: Science

The BSCS 5E Instructional Model (Bybee, et al, 2006) has been a highly accepted inquiry model in science instruction for over a decade and has been tested, endorsed, and funded by scientific organizations such as the National Institute of Health, the National Science Foundation, and The U.S. Department of Education (BSCS Science Learning, 2018). The following table (Table 2) is a direct, verbatim copy from *The BSCS 5E Instructional Model: Origins and Effectiveness*, a full report submitted to the Office of Science Education, National Institute of Health (Bybee, et al, 2006). This addresses the different phases of the BSCS 5E Instructional Model (henceforth called *5E*) of inquiry (Bybee, et al, 2006, p.2)

Table 2

Summary of the BSCS 5E Instructional Model (Bybee, et al, 2006, p.2)

Phase	Summary
Engagement	The teacher or a curriculum task accesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Exploration	Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.
Explanation	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaboration	Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluation	The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

The 5E inquiry cycle is focused on the teacher's role in guiding the student inquiry process. Teachers move their students through the phases of inquiry by eliciting prior knowledge to engage students, allowing students time to explore the materials and activities presented to them, and realigning the key concept(s) of focus. The phases further allow students to share their findings, provide opportunity for further understanding and investigation through the elaboration stage, and close with a student and teacher evaluation of the learning. Many of these tenets can also be seen in other inquiry cycles as well. One example is Guided Inquiry (Kuhlthau, Maniotes, Caspari, 2007; 2015).

Inquiry Model: Library

Guided Inquiry (Kuhlthau, Maniotes, Caspari, 2007; 2015) is a model for conducting inquiry in the K-12 school library environment. This is based in Kuhlthau's decades of research identifying the Information Seeking Process (ISP) of students (Kuhlthau, Maniotes, Caspari, 2015, p.221-226). The following chart (Table 3) directly quotes the eight phases and summaries of the Guided Inquiry cycle (Kuhlthau, Maniotes, Caspari, 2015, p. 55-58). This information was entered into chart format for ease of reading.

Table 3

Guided Inquiry Design Process

Open	"Invitation to inquiry, open minds, stimulate curiosity" (p.55)
Immerse	"Build background knowledge, connect to content, discover interesting ideas" (p.56)
Explore	"Explore interesting ideas, look around, dip in" (p.56)
Identify	"Identify inquiry questions, pause and ponder, decide direction" (p.56)
Gather	"Gather useful information, go broad, go deep" (p.57)
Create	"Create to communicate, reflect on learning, go beyond facts- interpret and extend" (p.57)
Share	"Learn from each other, share learning, tell your story" (p.58)
Evaluate	"Evaluate achievement of learning goals, reflect on content, reflect on process" (p. 58)

While the ordering of this inquiry cycle is different from the 5E, and there are more distinct steps, there are many components in Guided Inquiry that are also present in the 5E model. The model begins by eliciting curiosity and engaging students, building on prior knowledge, allowing students to explore the materials, examine their own inquiry question, collect information, share results, and evaluate their learning cycle. When placed side-by-side the similarities between these inquiry cycles becomes even more evident. (Table 4).

Table 4

Comparison of Guided Inquiry and BSCS 5 E Inquiry Cycles

Guided Inquiry	BSCS 5 E Inquiry
"Stimulate curiosity" (Open, p.55)	"Promote curiosity" (Engagement, p.2)
"Build background knowledge" (Immerse, p.66)	"Elicit prior knowledge" (Engagement, p.2)
"Connect to content" (Immerse, p. 66)	"Connect to past and present learning experiences" (Engagement, p.2)
"Explore interesting ideas" (Explore, p.56)	"Generate new ideas" (Exploration, p.2)
"Identify inquiry questions" (Identify, p. 56)	"Explore questions and possibilities" (Exploration, p.2)
"Go broad [find a range of sources] go deep" (Gather, p.57)	"Through new experiences, the students develop deeper and broader understanding" (Elaboration, p.2)
"Go deep [gain personal understanding]" (Gather, p. 57)	"to demonstrate their conceptual understanding, process skills, or behaviors" (Explanation, p.2)
"Create to communicate" (Create, p.57)	"Learners explain their understanding of the concept" (Explanation, p.2)
"Go beyond facts- interpret and extend" (Create, p.57)	"deeper understanding" (Explanation, p.2)
"Share learning, tell your story" (Share, p.58)	"Learners explain their understanding of the concept" (Explanation, p.2)
"Evaluate achievement of learning goals [the Learning Team evaluates students' achievement of the learning goals]" (Evaluate, p.58)	"Teachers to evaluate student progress toward achieving the educational objectives" (Evaluation, p.2)
"[Students] reflect on content, reflect on process" (Evaluate, p.58)	"Students to assess their understanding and abilities" (Evaluation, p.2)

Set side-by-side in Table 4, it can be seen that not only do the main ideas of these two models overlap, but much of the wording is very similar between these two inquiry cycles. However, it should be noted that much like the comparison of the national standards of the previous section, some of these comparisons are very evident, while others require interpretation. For example, "Stimulate curiosity" (Open, p. 55) and "Promote curiosity" (Engagement, p.2) are very similar in both wording and meanings, where some other comparisons are not so directly similar. For example, "Create to communicate" (Create, p.57) has a different emphasis than "Learners explain their understanding of the concept" (Explanation, p.2). Guided Inquiry stresses the importance of creating a product in order to communicate ideas rather than simply explaining understanding. In this instance, my focus for this connection was on the student process of relaying and sharing information they have learned with their peers and/or teacher, rather than the reason why, or the end product.

A New Inquiry Model

As can be seen, there are many similarities between these two inquiry models. While they are comprehensive inquiry models for their respective fields, a model containing components from both models was necessary for this research study. Guided Inquiry provided the framework for nonfiction information inquiry I utilized in this study, whereas the BSCS 5E provided the hands-on exploration and inquiry I also required for this study. As a result, I merged common terminology and themes from both inquiry models to develop a hybrid inquiry model which incorporated the aforementioned commonalities and also included the discipline-specific, unique components. The following table (Table 5) contains the Guided Inquiry phases in the left column, and BSCS 5 E phases in the right column, with the new inquiry model, the Science in the School Library Inquiry Model (SSLIM) phases in the center column.

Table 5

Science in the School Library Inquiry Model Hybrid

Guided Inquiry Phase	Science in the School Library Inquiry Model	BSCS 5E Phase
Open / Immerse	**Involve:** Use literature to introduce new concepts, connect to prior knowledge, engage students, and elicit curiosity through discussion.	Engagement
Explore/ Identify	**Enquire:** Explore questions, generate new ideas, identify individual inquiry question.	Exploration
Gather /Immerse	**Inquire (Library):** Locate useful information, connect questions to nonfiction content, gain understanding.	
	Inquire (Science): Engage in inquiry science activities, connect nonfiction information to hands-on experience, work with teacher(s) and students to explain understanding, draw conclusions, generate new ideas and questions.	Engagement / Exploration / Explanation
Create / Share /Evaluate	**Elaborate:** Reflect on experience, assess learning, share and compare results, extend ideas and theories.	Elaboration/Evaluation

While this new inquiry model blends both the common and unique ideas and themes of Guided Inquiry and the 5E inquiry models, it lacks the explanation of how the model is implemented throughout each phase. The following table (Table 6) seeks to more fully explain the implementation of each stage, as well as identifies the teacher and student roles throughout the process.

Table 6

Explanation of Stages of Science in the School Library Inquiry Model

Science in the School Library Inquiry Model
Involve: This is an introduction to the larger concept through literature, and also the space and time when the teacher involves the students in their future inquiries through discussions, personal experiences, questions and answers, and/or a review of the available experiential stations.
Enquire: Students take the lead, creating their own individual and unique question(s). Teacher assists as necessary. Students record their questions in science journals.
Inquire (Library): Students conduct inquiry in various non-fiction resources. These could be books, online sources, video clips, models, etc. Teacher assists as necessary. Students record their findings in their science journals.
Inquire (Science): Students choose the experiential station that they believe will best answer their question. They conduct hands-on inquiry to test their ideas (both personal and from non-fiction sources) and draw conclusions. Teacher assists as necessary. Students record their findings in their science journals.
Elaborate: Because each student explored a unique question, the teacher actively steps back in at this time to assist students by grouping similar lines of inquiry. In these groups, students discuss topics, compare findings, and draw conclusions. Groups then share their collective results with the whole class for discussion and comparison to the larger unit.

While both the national standards and the inquiry cycles of library instruction and science instruction align in many ways, these are not the only commonalities between school library instruction and science instruction. Literature, a key component in Guided Inquiry (Kuhlthau, Maniotes, Caspari, 2007; 2015) and the SSLIM, is also an important aspect in science instruction. In the following section I explore research which utilizes science trade books in science instruction, as well as the importance of careful curation of science trade books.

Common Goals

Science Instruction with Literature

The year 2018 marked the forty-fifth annual publication of the *Outstanding Science Trade Books [for K-12 Students],* a joint effort by the National Science Teachers Association

(NSTA) and Children’s Book Council (CBC) (National Science Teachers Association, 2018). This publication provides a list of age-appropriate science trade books which “…have value for both classroom studies and library collections…” (Children’s Book Council, 2019). Through the continuation of this annual publication, it is evident that the National Science Teachers Association and the Children’s Book Council have a long-standing history of recognizing the mutual benefits of utilizing high-quality science trade books in both classroom instruction, as well as library collections. This indicates an implied understanding of the ways science literature can contribute to both areas of the school. It also indicates that the NSTA has, for some time, held high regard for using trade books in science instruction.

Research has also indicated the importance of incorporating trade books as a supplement to science instruction. One example is the study conducted by Varelas, Pieper, Arsenault, Pappas, & Keblawe-Shamah, (2014), in which third grade Latina/o students were observed during five days of science instruction using read-aloud science literature with discussion, and hands-on inquiry-based science. This inquiry unit, about earthworms, was one portion of a larger unit on forests. The lessons utilized three pieces of science literature, which were presented during read-aloud instruction and discussion, and were read over the course of the five total lessons. The teacher utilized these texts as a means to introduce science concepts and to promote student discussion. The students then participated in hands-on inquiry activities with live earthworms, which culminated in students recording field notes and observation in their journals. The incorporation of the non-fiction texts provided students with access to new vocabulary, verbally transmitted information, and pictures/diagrams which were then applied to the inquiry portion of the unit. During both the readings and the physical inquiry, the children shared causal, comparative, analogical as well as personal contributions, thus creating a collective knowledge of the subject. In addition, the use of literature clearly affected the students' hands-on experiences, as the student journal entries "revealed that children noticed on the real worms, features that they had discussed during the previous read-aloud" (Varelas, et al., 2014, p. 1260). This indicates literature may significantly guide and influence the ways students learn during hands-on science activities.

In another study, Sharkawy (2012) examined young children's perceptions about the collaborative nature of science and scientists. This study looked at 11 first-grade students, over a 13-week intervention. Sharkawy started the research with the Draw-a-Scientist Test (DAST), where students drew what they thought a scientist looked like. She then interviewed the students to see what their perceptions of scientists were. During the intervention, she introduced students to diverse scientists with an emphasis on the collaborative nature of scientific work, for 40-50 minutes weekly through literature, storytelling, and videos. These stories displayed diversity in gender, culture, race, and showed scientists with disabilities. After completion of the scientist lessons, the students again participated in the DAST activity and interviews. The results of the DAST showed a significant increase in student understanding of the collaborative nature of science, scientists utilizing information sources to conduct research, and scientists sharing their results with the greater community; all ideas that were missing from the initial DASTs where students drew scientists in complete solitude, with only one student drawing a scientist writing in a book. This study again implies the important role that literature and story may play in the conceptual formations of ideas about science and scientists with young children.

It should be noted, however, that not all science literature contains a comprehensive depiction of scientific practice, nor are the different domains of science equally represented in children's literature or in library collections. There have been several research studies examining the quality and quantity of science topics, concepts, and themes in children's trade books, with all indicating the necessity of critical selection. In the study conducted by Ford (2005), one-quarter of the books selected from the science non-fiction section of a public library had no explicit representation of natural or practical sciences present in the text. In addition, only a little over one-third of the books which did contain science representations mentioned investigation as a scientific method (Ford, 2005). It also appears that life sciences tend to heavily outweigh all other sciences in children's books, with books about the physical sciences having the lowest representation in collections (Ford, 2005; Smolkin, McTigue, Donovan, & Coleman, 2008). Scientists may also be misrepresented in children's trade books. Perhaps as a result of simplifying the information for young readers, Dagher and Ford (2005) found that the scientific biographies selected from a recommended list by *The Horn Book Guide,* had large amounts of missing information about the lives and practices of scientists, and often supported myths about scientists such as heroic qualities and infallibility. Furthermore, there was an overemphasis on observation and contemplation with little emphasis on curiosity and investigation and almost no mention of the goals of scientific research. So, while literature can offer an important support to science instruction, it should be critically evaluated for use with science instruction. School librarians are in an optimal position within the school to conduct this type of careful selection.

School Librarian as Expert in Literature Selection

The school librarian has a long tradition of supporting all subject areas through, among other things, literature. Certified school librarians "…evaluate and select print, non-print, and digital resources using professional selection tools and evaluation criteria to develop and manage a quality collection designed to meet the diverse curricular, personal, and professional needs of students, teachers, and administrators" (American Library Association, 2010a, p.17). Through this extensive selection and evaluation process, the certified school librarian can select or assist teachers in selecting literature that is well matched to science curricular objectives.

In addition, the school librarian is trained and certified to assist students in finding materials that are both appropriate for the students' reading levels and that are appropriate to their chosen topic. They "…develop a collection of reading and information materials in print and digital formats that support the diverse developmental, cultural, social, and linguistic needs of P-12 students and their communities" (American Library Association, 2010a, p.6). The school librarian may also know of online resources that classroom teachers may not know (Mardis, 2015) or alternate resources like books on tape, books in other languages, or large print books for students with special needs (Whittingham, Huffman, Christensen, & McAllister, 2013). If these resources are not immediately available, the school librarian often has the ability to acquire these items from other schools or libraries through inter-library loans (Subramaniam, et al., 2013). Because of the necessity of quality science literature, and the school librarian's expertise in trade book selection tailored to student level and need, the school librarian can be an integral support to the science teacher and the science curriculum. However, school libraries and science instruction have had their own different yet, once again, similar struggles in education. These struggles may inhibit, or even prevent, the communication between the librarian and the science teacher and may diminish supports, such as librarian assistance in selecting quality science literature for the science program.

Cuts to school librarian positions, decreased science instruction in the elementary school, and lack of an established common planning time between school librarians and teachers may hinder planning and collaboration between the librarian and the science teacher. Furthermore, these factors may cause a disconnect between the school librarian and the classroom teacher regarding understanding what each other does and how their programs can support each other. These deficiencies will be explored in the following sections.

Similar Even in Problems

Both libraries and the sciences face challenges within their own disciplines. While school librarians are often the targets of school budget cuts, perhaps due to an unknown value of what they do, science is often marginalized due to testing constraints, over-simplified curriculums, and lack of teacher efficacy in teaching science. The following section presents a more in-depth look at the problems facing educators in both disciplines.

Cuts to School Librarians

In a recent publication in *School Library Journal*, Yorio (2018) states “in large and small towns across the United States, school librarian positions are being eliminated at an alarming rate” (para. 1). However, these cuts are not new to the field of school librarianship. A recent publication by Lance (2018) examines the trend of the decrease of school librarian positions, since the turn of the millennium. Lance utilized data from the National Center for Education Statistics which indicates that since the year 2000, there has been a decrease of approximately 10,000 school librarian positions across the nation, which translates to nearly 20% of the workforce. While many of these cuts originated during the Great Recession, other areas of school cuts from that time have rebounded, where school librarian positions have continued to decrease (Lance, 2018).

However, school librarians have historically shown, time and again, their worth in the education of students. In studies dating back to the early 1960s, the presence of a qualified school librarian positively correlates to higher student achievement. In Gaver’s (1961) seminal research she found, “The scores on the difference between grade-equivalent scores of the *Iowa*

Test of Basic Skills at fourth- and sixth-grade levels indicate that higher educational gain is associated with schools which have school libraries" (p. 256). More recently, but still over two decades ago, Keith Curry Lance spurred on a new era of correlational research with his first Colorado study, *The Impact of School Library Media Centers on Academic Achievement* (1992). This research examined the reading test scores of 221 public schools in Colorado. The results, though on a much larger scale, mirrored those of Gaver's, three decades earlier: The presence of a qualified school librarian correlated to higher test scores (Lance, 1992). Since the first publication by Lance, dozens of correlational research studies have shown these same results, over years and throughout numerous states in the United States (Library Research Service, 2013). These studies have shown a positive correlation of the presence of a qualified school librarian and higher student test scores. However, it should be noted, these studies are correlational and do not establish causation. They have also been limited primarily to reading and writing test scores with no current studies examining this same correlation to science achievement.

However, libraries are not the only area of the school that may suffer from marginalization. Science instruction may be deprioritized to other, more tested subjects. Additionally, teachers who feel unprepared to answer student questions about science may avoid science content, or there may be a combination of these factors.

Decreased Science Instruction

Science instruction has seen its own marginalization in US schools in recent years. Teachers may be under pressure to teach to standardized tests, which may not include science. Teachers may also feel underprepared to teach and answer questions about science. However, this avoidance of science was not always the case. There was once a strong educational push to support the sciences.

Soon after the launch of Sputnik in 1957, extra attention was paid to science education in United States public schools. This began with the National Defense Education Act, which "marked the beginning of large-scale involvement of the U.S. federal government in education" (Hunt, 2018, para. 2). During this time science was at the forefront of the nation's focus in education. "Of particular concern was bolstering the United States' ability to compete with the Soviet Union in the areas of science and technology" (Hunt, 2018, para. 1). However, relatively recently, this national focus has shifted to language arts and mathematics. This shift may have begun with the implementation of the "standards-and-testing movement" (Rudalevige, 2003, para. 2) of the *No Child Left Behind Act* (NCLB) of 2001 (U.S. Department of Education, 2017), which implemented a national emphasis on standardized testing. However, while NCLB began the trend of utilizing standardized testing nationwide as a means to measure student achievement, it did include science as a tested subject. Arguably, science may have truly taken a backseat the language arts and mathematics with the development of *The Common Core State Standards Initiative* (referred to as "Common Core" henceforth), launched in 2009 (Common Core State Standards Initiatives, 2019a) which were developed to establish a "set of clear college- and career-ready standards for kindergarten through 12th grade" (Common Core State Standard Initiative, 2019d, Frequently Asked Questions). However, while the Common Core addressed a common set of testable standards for schools to follow in language arts and mathematics, they lacked explicit science standards, especially at the elementary school level.

The Common Core is a set of academic standards for K-12 students. The learning goals outline "what a student should know and be able to do at the end of each grade" (Common Core State Standards Initiative, 2019a, para. 2). While there are limited but direct, references to science in the 6-12 curricula, for example, “Cite specific textual evidence to support analysis of science and technical texts” (Common Core State Standards Initiative, 2019b, CCSS.ELA-LITERACY.RST.6-8) these explicit scientific requirements are absent at the elementary (K-5) level. The “standards for K-5 reading in history/social studies, science, and technical subjects are integrated into the K-5 Reading standards” (Common Core State Standards Initiative, 2019c, para. 1). The Common Core standards have minimal mention or emphasis on science and no mention of scientific inquiry at any level. In 2013, four years after the release of the Common Core, the *Next Generation Science Standards* (NGSS Lead States, 2013) were released.

These new science standards were developed by the National Research Council (NRC), the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS), and in conjunction with 26 states, and addressed the need for a new set of national science standards to address the critical area of need in science education. “[T]he U.S. system of science and mathematics education is performing far below par and, if left unattended, will leave millions of young Americans unprepared to succeed in a global economy” (NGSS Lead States, 2013, The Need for Standards). For example, in 2016, 64% of high school graduates failed to meet the American College Testing (ACT) readiness benchmark level in science (ACT, 2016); 66% of eighth grade students failed to meet proficient achievement in science, with 32% scoring below the basic level in science on the National Assessment of Education Progress (National Assessment of Educational Progress, 2019); the United States was ranked 25th in science by the 2015 Program for International Student Assessment (PISA) (OECD, 2018). In addition, the amount of technology patents being filed by US citizens has decreased, with over half (52%) of the US patent applications being filed by foreign competitors. (US Patent and Trademark Office, 2019). These new science standards were developed in response to the need for updated science standards and quality science education for all students (NGSS, Lead States, 2013). However, this was after four years Common Core and of high-stakes national standardized testing, dedicated primarily to language arts and mathematics.

At this time, 41 states, the District of Columbia, and four US territories have adopted the national standards for language arts and mathematics set forth by the Common Core (Common Core State Standards Initiative, 2019) whereas only 20 states and the District of Columbia have adopted the national standards for science set forth by the NGSS (National Science Teachers Association, 2014). These state participation numbers may indicate a possible deficiency in the perceived necessity of a standardized and unified nationwide science curriculum, as compared that of language arts and mathematics.

Science scores are falling behind those of language arts and mathematics at the elementary level as well. In 2010, the National Center for Education Statistics initiated the *Early Childhood Longitudinal [Study] Program of 2011* (ECLS-K:2011). This study examined a national sampling study of 18,174 children who entered kindergarten in the fall of 2010. The national researchers of this study followed this cohort of students through the spring of 2016 when most of the students were in fifth grade. While the primary purpose of this longitudinal study was to provide researchers with data about “family, school, community, and individual factors [which] are associated with school performance over time” (National Center for Education Statistics, 2019, Study Information), the reported *Findings from the First-Grade Rounds of the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11* (ECLS-K:2011) also examined the mean scale results from reading, math and science scores over the school year. From fall 2011 to spring 2012 mean reading scores of first grade students improved from 56.8 to 70.7 out of a possible score of 100; mean mathematics scores increased from 51.5 to

64.0 out of a possible score of 96, while mean science scores only increased from 23.9 to 27.1, out of a possible score of 47 (Mulligan, McCarroll, Flanagan & Potter, 2014). Improvement for second grade students follows: Reading increased from 90.5 to 97.7 (out of a possible score of 120); mathematics increased from 72.9 to 81.9 (out of a possible score of 113); science increased from 39.8 to 44.1 (out of a possible score of 64) (Mulligan, McCarroll, Flanagan & Potter, 2015). This means that from the fall of first grade, until the spring of second grade, language arts increased from an average of 58% to 81%, mathematics increased from an average of 54% to 72%, while science both started and ended the lowest with an increase of 51% to 69%. These scores stayed relatively steady in third grade (Mulligan, McCarroll, Flanagan, and Potter, 2016) and fourth grade (Mulligan, McCarroll, Flanagan, and Potter, 2018) with science scores never reaching 70% achievement. The following line graph (Figure 1) gives a visual representation of the average percentages of scores for each testing cycle.

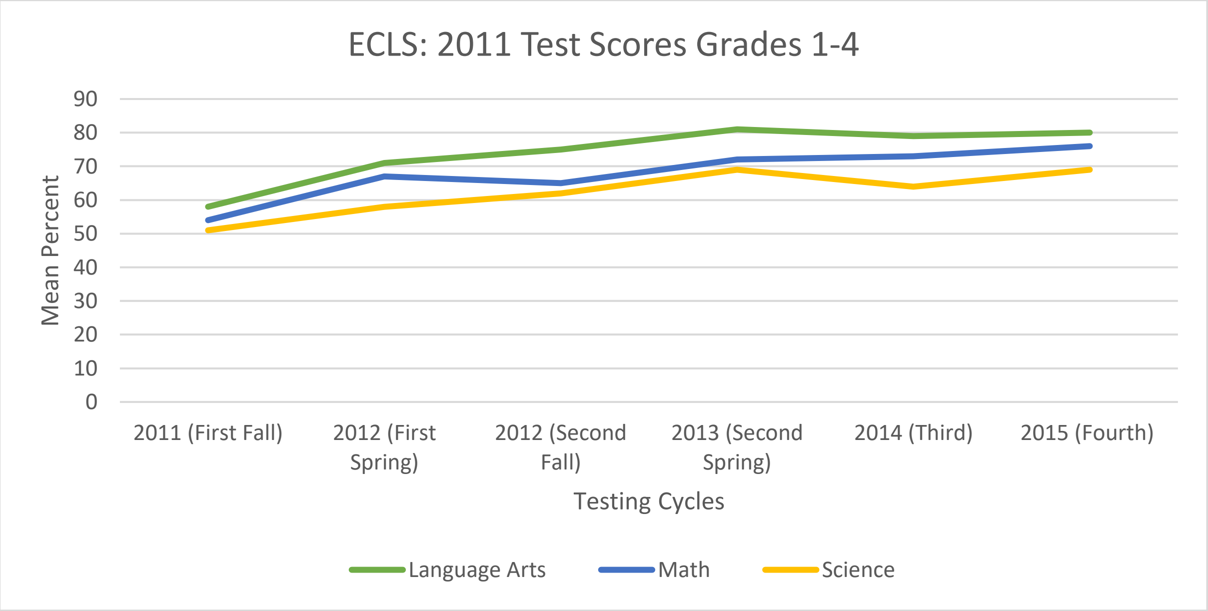

Figure 1. ECLS Test scores grades 1-4

This indicates that not only are students coming into first grade with lower levels of science knowledge than that of reading and mathematics, but that science continues to remain the lowest scoring subject throughout the early childhood years and into the elementary years. This lagging in science achievement may also have implications on the ways that students view science, what they believe authentic science looks like, and how they feel about science by the time they exit elementary school.

Student Attitudes about Science

Researchers generally agree that students may have already formed strong opinions and perceptions of science and scientists by the time they exit elementary school (Archer, Dewitt, Osborne, Dillon, Willis & Wong, 2010; Murphy & Beggs, 2005). When approximately 1000 school-aged students, grouped by ages of 8-9 and 10-11, were administered surveys about their interest in different topics of science and doing science in general, there was significant degradation in positive perceptions of science in the 10-11-year-old group (in both in male and female students) as compared to 8-9-year-old group (Murphy & Beggs, 2003). Based on students' written and/or verbal responses, Beggs and Murphy concluded, "It provides evidence that this erosion in interest could be due to lack of experimental work, repetitive topic revision and practice assessments for national tests, and inappropriate curriculum content that does little to awaken children's interest" (p. 115).

In their research, Archer, et al. (2010) further explored the degradation age revealed by Murphy and Beggs (2003) by conducting interviews with 10 and 11-year-old students to examine more in-depth, their perceptions about science at this age. Though the 10 and 11-year-old students in the study did generally portray positive attitudes toward science, there were other potentially damaging ideas that were already formulated by that age. While the majority of students claimed to enjoy science, most did not have an interest in becoming a scientist or pursuing higher levels of science education. Science was overwhelmingly described as "hard" or "brainy" and scientists were often portrayed by students as eggheads or nerdy. Additionally, the students portrayed school science instruction as "safe science" while "real science" was dangerous and only conducted outside of a school setting. These student misconceptions about science and scientists could indicate that these students may not have been receiving well-developed instruction about the nature of science and scientific inquiry.

Similar negative perceptions and deficiencies in science knowledge can be seen at even younger ages of students. In research conducted by Patrick, Mantzicopoulos, and Samarapungavan (2008) nine similar kindergarten classes were selected from three different schools in a quasi-experimental research study. Six classes were selected as treatments groups and participated in a Science Literacy Project (SLP), where the remaining three served as the control group. Of the six treatment classes, three classes received five weeks of SLP instruction, and three received SLP instruction for 10 weeks. During the SLP intervention, students were instructed for 60 minutes, twice weekly. This literacy instruction consisted of integrated inquiry and literacy activities. While the control group did not receive SLP instruction, it continued to receive the already present, thematic, science curriculum where classroom science instruction was integrated into week-long themes such as "animals," or "seasons" (p. 173). While this research was conducted primarily to examine student motivation and any evidence of a preexisting gender gap in science knowledge by kindergarten age, multiple other significant findings emerged. One significant area of growth was the measurement of change in student perceptions of science. The students in the treatment groups showed significant increases in enjoyment of science and motivational beliefs about becoming a scientist after the SLP instruction, where the control group showed no statistical change. This research demonstrates that the accepted age of 10-years-old may be skewed in the realm of negative feelings about science, as young students may enter their educational career with negative ideas and feelings about science. Furthermore, the research indicates that positive results can be achieved through the implementation of science literature and inquiry activities over relatively short spans of time.

These research studies indicate that a lack of authentic scientific inquiry may be fueling student misconceptions about science, who does science, and what science looks like. In turn, these misconceptions may be diminishing intrinsic motivations to pursue a career in the sciences. The import of these findings may help to establish the relevance of authentic inquiry-based science instruction at all levels of the elementary school. However, educators also face pressures in instructional time and may, themselves, have misconceptions or uncertainty about what authentic science inquiry looks like.

Factors Affecting Science Education in Elementary Schools

One issue which may be affecting science instruction is the factor of time. With the mounting national pressure in standardized instruction and testing requirements of initiatives like *No Child Left Behind* and *Common Core*, teachers may feel added pressure to teach tested subjects such as language arts and mathematics, thus leaving less time for science and other non-tested subjects (Griffith & Scharmann, 2008). In some instances, teachers are not even addressed by administrators about non-tested subjects, such as science (Patrick, Mantzicopoulous, & Samarapungavan, 2008). This is may be producing gaps in the science education of young children.

Another reason science education may be falling behind in elementary education might be due to elementary teachers avoiding science instruction. Some elementary teachers have indicated that this is due to their own lack of science knowledge, as many teachers enter the field with little personal experience or education in the sciences (Appleton, 2003). As a result, many have lower confidence in their ability to effectively teach science concepts (Appleton, 2003). This lower confidence, or low self-efficacy, may affect how and what they teach in science.

In looking at Social Cognitive Theory (Bandura, 1977), self-efficacy has been identified as a factor in individual achievement and goals. “Self-efficacy refers to perceptions of one’s capabilities to produce actions…” (Schunk, 2012, p. 146). This seems especially true in education. This belief of one’s capabilities can greatly affect the learning environment and risks a teacher is willing to take. Bandura states, “The task of creating learning environments conducive to development of cognitive skills rests heavily on the talents and self-efficacy of teachers” (Bandura, 1993, p. 140). Self-efficacy may affect what teachers feel comfortable teaching. But this lack of self-efficacy is not only evident in the general education classroom teacher.

These self-efficacy beliefs may also naturally apply to school librarians as general educators. Low librarian self-efficacy in a subject, such as science, may result in avoidance of planning, collaborating, and teaching within that subject. This could be one possible reason we have not seen very much empirical research on science instruction in the school library, as the school librarian, a general educator, may also be less comfortable with science than other subjects (Mardis, 2007; Schultz-Jones & Ledbetter, 2009; Rawson, Anderson, & Hughes-Hassell, 2015). This also is evident at the pre-service level of instruction, as pre-service teachers and pre-service librarians, both, voiced feeling of discomfort when planning science integrated lessons, due to a lack of knowledge of the subject (Rawson, Anderson, Hughes, & Hassell, 2015). This lack of knowledge may affect their self-efficacy of teaching science. Thus, science instruction may be avoided by classroom teachers and librarians alike, as general education elementary teachers and librarians with low levels of self-efficacy in an educational area, may be more likely to avoid that topic (Schultz-Jones & Ledbetter, 2009).   Research also indicates that unless these teachers and librarians have a background in science, they tend to not feel confident answering student science questions correctly (Montiel-Overall, P. & Grimes, K., 2013).

Perhaps due to a combination of these issues, science achievement lags behind that of language arts and mathematics in the elementary school. However, through successful library and science collaboration, many of these problems with efficacy can be overcome, and the combination of library and science lessons may alleviate some time constraints in teaching science for classroom teachers. Unfortunately, while collaboration is a mainstay of the school library program, there may be a bidirectional problem with school librarians and science teachers in understanding what can be accomplished in a collaborative environment (Mardis, 2007; Schultz-Jones & Ledbetter 2009; Montiel-Overall, & Grimes, 2013).

School Librarian and Science Teacher Collaboration

A foundation of the school library program lies in the ability of the school librarian to collaborate with teachers to plan and teach effective lessons. “Collaboration, a mainstay of the school library media field, has also changed since the original [National Board] *Library Media Standards* were published…. Today, integrating instruction involves working not just with information literacy but with multiple literacies across the curriculum” (National Board Professional Teaching Standards, 2012, p. 16). This is supported by research that indicates collaboration may be inherently beneficial for all parties involved. In analyzing a year of regularly scheduled, collaborative planning meetings with the school librarian and second-grade teachers, Kimmel (2012) found the “[planning] activities bear strong similarity to many models of instructional design or problem solving, suggesting the learning inherent in the planning activities" (p.12). While certified school librarians are taught to "model and promote collaborative planning, instruction in multiple literacies, and inquiry-based learning…" (American Library Association & American Association of School Librarians, 2010b, p.1), this is not always the case with science. Mardis (2007) identified the mutual disconnect between the school librarians and science teachers in Michigan middle schools. Within this research, evidence was presented that the "absence of connection between school library media specialists and science educators may be a bidirectional problem" (Mardis, 2007, p.2). This research spurred others to examine the relationships, or lack thereof, between school librarians and science teachers. Schultz-Jones and Ledbetter (2009) followed this with their research study which expanded on Mardis' research. In this study, questionnaires and interviews revealed that science teachers often did not know their school librarian, what the school librarians' educational responsibilities were, or the education necessary to become a certified school librarian. In addition, librarians surveyed did not know how to go about planning with the science teacher and often indicated that they did not feel confident enough in their personal knowledge of science to initiate planning with science teachers. This hesitance to teach science is not limited to librarians, as aforementioned, many practicing general education teachers are hesitant in personal ability when teaching science (Appleton, 2003; Riggs & Enochs, 1989.) However, it continues to be an area in need of addressing by school librarians nationwide (Subramanian, 2015).

Dedicated Collaboration in Science Works over Time

Montiel-Overall and Grimes (2013) added to the research base with the success of a two-year, qualitative, longitudinal study addressing school librarians' and elementary teachers' collaborative efforts in monthly professional development meetings on hands-on science instruction. This research demonstrated how the groups of teachers and librarians, along with science and collaboration mentors, overcame their hesitance in collaboration and science instruction over the course of two years. This research among other things presented the phases of trust-building that occurred over time and examined the importance that the mentors played in the planning sessions. This is significant in pointing to the important role a mentor may play in facilitating effective planning and collaboration of authentic inquiry-based science for student lessons when the librarian and classroom teacher are unsure of how to accomplish this task.

In response to this research, Rawson (2014) identified the need for “research to identify beliefs and perceptions of pre-service science teachers and librarians regarding collaboration and interventions that might make collaboration more likely once these students transition into practice” (p.26). Rawson herself addressed this research need (Rawson, Anderson, & Hughes-Hassell, 2015) through a semester-long, qualitative research study which examined the collaborative efforts of pre-service school librarians and pre-service elementary teachers, collaborating on science instruction. Even this single project, research study resulted in an overall improvement in the preservice school librarian’s understanding of science focused collaboration with classroom teachers. All of these studies point to the benefits of school librarian and classroom teacher collaboration in science instruction, however, what remains largely unknown is how school librarians plan and implement novel and/or unfamiliar content into their library programs when these knowledge-building, collaborative opportunities are limited, or not available to them.

Fixed Scheduling

The United States Census Bureau (2011) identifies a fixed library schedule as a “…type of scheduling for classes and other activities for the library media center [using] previously specified times …" (p. 4). Whereas, a flexible library schedule is a "…type of scheduling for classes and other activities for the library media center [which are] available as needed…" (p. 4). By these definitions, classes in a fixed library schedule are determined by *time*(s), versus a flexible schedule which is determined by *need*(s).

While there is research present that shows evidence of the potential benefits of regular school librarian/teacher collaboration (Kimmel 2012; Montiel-Overall & Grimes, 2013; Rawson, Anderson, & Hughes-Hassell, 2015) there is very little empirical research on librarians in fixed-schedules, with none able to be located on how the school librarian constructs novel science instruction without the benefits of classroom teacher collaboration. While there are benefits to both the school librarian and the classroom teacher during regular science collaboration, collaborative opportunities may not be a possibility for over one-third of the nation's elementary school librarians. In the most recent analysis of school library demographics from the School and Staffing Survey (SASS) (Bitterman, Gray, & Goldring, 2013) 30.2% of elementary school libraries nationwide are in completely fixed schedules. Van Deusen & Tallman (1994) found that school librarians in fixed schedules were less involved in collaborative planning as compared to those in a flexible schedule. In addition, school librarians in fixed library schedules may be viewed as a resource for classroom teacher planning time (Gavigan, Pribesh & Dickinson, 2010), thus diminishing or eliminating teacher/librarian collaboration opportunities. Furthermore, while ALA / AASL (2010a) *Standards for the Initial Preparation of School Librarians* mandate the need for collaboration: "Candidates can document and communicate the impact of collaborative instruction on student achievement" (p.1), there is nothing addressing situations where school librarians are not afforded time for collaborative planning with teachers. And while it may be possible for the school librarian to accomplish a level of collaboration in a fixed schedule, it requires some sort of regular communal times with the librarian and the classroom teacher (Formanack & Pietsch 2011; Rowe, 2007). Yet, little research is present addressing how this additional collaborative planning time can be achieved within the constraints of a standard school day.

Science in the School Library

This is not to say that collaboration in science is not happening, or that science is absent from the school library. To the contrary, there have been relatively recent movements in the school library community to include Science, Technology, Engineering and Mathematics (STEM) activities within the school library through various types of makerspaces, robotics clubs, and science clubs/activities (Abram, 2015). However, many of these opportunities take place in after school, weekend, or “free time” settings (Gustafson, 2013). While these may be beneficial to students, empirical research examining the impact of inquiry science instruction in the school library during the instructional school day, and the effect on student science achievement, is largely absent from the research.

A Mutually Beneficial Combination

Learner-Centered Inquiry

As aforementioned, “inquiry” incorporates fundamental skills for students that are present in both library and science learning and are addressed in both sets of national standards. True scientific inquiry instruction is one that focuses on “connecting to students’ interests and experiences” (Framework, 2012, p.28). This is also seen in the *AASL Framework for Learners* where students “Engage[ing] in inquiry-based processes for personal growth” (AASL, 2018, V.A.3). This method of student selected, and student-driven inquiry instruction can also be found in the learner-centered ideology (Schiro, 2013) which builds the learning environment around student-driven interests. With these ideals in mind, science instruction in the library could give the students opportunities to explore their own personally chosen avenues of inquiry, within set guidelines and opportunities. Because of the nature of allowing students to initiate their own line of inquiry, there is no way to comprehensively preselect books/materials in a way that would be sufficient for all learners. The breadth and depth of the school library collection would, however, be more ideal for diverse student-driven questions. This is not to say that books can't be pulled and readily available, but rather that the library collection offers a multitude of materials to address more diverse areas of questioning which may not have otherwise been anticipated by the teacher or librarian.

If science inquiry and information inquiry happened in the same place and time, it could allow students to select materials that are best suited for them and their personal line of inquiry during the point in time in their investigations when it is most appropriate. Where, much like real-life scientific research, students question and seek answers in both the inquiry of the text as well as the inquiry of the object or experiment. For example, a student may want to investigate how a seed sprouts. While a book may provide pictures, in the "library laboratory" the student could then dissect an actual bean sprout, examine the specimen, compare the two, and then move along to his/her next line of inquiry. Perhaps the vascular structure of the young plant, leading the student to now explore an interactive webpage, or a time-lapse video of plants growing, rather than a book. The research/investigation cycle can then begin again, with materials available for each individual student's interest. In addition, it negates the obvious complications of attempting to anticipate the preselection of all the literature that would apply to each possible line of inquiry for each student. This additionally solves another library dilemma: mass pre-selection and checkout of materials for classroom use which can deplete the library collection for other classes/students/teachers looking for those materials. When the library is reimagined as a science laboratory, the science materials and investigation are used and housed in the same central space with students selecting only the books or other materials that are appropriate for their personal line of investigation. This scenario of a possible hybrid of information inquiry and science inquiry would allow students agency in their personal lines of inquiry and the opportunity to work together and/or individually, as they chose. Through successful collaboratively built science and library inquiry, effects may be seen on the efficacy of the librarian as well. This scenario was built on theoretical frameworks and curricular ideology presented below.

Theoretical Frameworks

The theoretical frameworks used to structure this research were the similar theories of constructivism put forth by Lev Vygotsky (1978) and Maria Montessori (1995). I selected these constructivist frameworks due to their focus, specifically, on the education of young children. In addition, the learner-centered ideology I used in the construction of this research study is based on the fundamental components of the constructivist framework, which gives agency to the student in choosing their educational path. Also, I employed the theory of self-efficacy put forth by Albert Bandura (1977) as a growth measure for the school librarian. I developed this research study through the lenses of these frameworks and ideology.

Constructivism

Constructivism is the act of constructing knowledge within the social environment of learning. Vygotsky (1978) identifies the realm between mastered knowledge and the potential for knowledge mastery as the Zone of Proximal Development (ZPD). “It is the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (p. 86). Through working under the guidance of the teacher, and with his/her peers, the student is able to learn at a more individualized pace which encourages individualized learning. "We propose that an essential feature of learning is that it creates the zone of proximal development; that is learning awakens a variety of developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers" (p. 90). Through this research study, I sought to employ these social components of Vygotsky's theories through teacher guided and optional student cooperative opportunities. However, students may not always choose to work with peers on a given day or activity. In some cases, students choose to work and problem-solve in solitude.

Montessori (1995) addressed the individualized education and development of the early child as one of the most difficult and significant times in the life of a person. During this time in the child's life, development rapidly goes from no control over the body, to walking, language acquisition, imitating, and learning. In this respect, she addressed each age and stage of child development as one of individual, self-propelled growth and learning. During this time the student is their own motivator in their learning and education. "Mothers, fathers, politicians: all must combine in their respect and help for this delicate work of formation, which the little child carries on in the depth of a profound psychological mystery, under the tutelage of an inner guide" (Montessori, 1995, p.17). She felt that giving students the tools to work with to develop their own lines of inquiry in areas of interest of their own choosing, as well as the chance to discover their own interests, were the most beneficial structures in the education and development of the child.

While Montessori focused primarily on the development and learning of very young children (age birth – six or seven years old) current standards deem children up to the age of eight years old as “early childhood” students (NAEYC, 2019a). Montessori’s theories about how children grow and learn as well as her focus on movement and independently driven learning are integral to the development of this research. In contrast to Vygotsky, Montessori states, “The child seeks for independence by means of work; an independence of body and mind. Little he cares about the knowledge of others; he wants to acquire a knowledge of his own, to have experiences of the world, and to perceive it by his own unaided efforts” (p. 91). Because of the contrasting portions of these similar theories, we built the lessons in this research to allow student agency in the choice of participating in individual and/or collaborative learning experiences, or to move between them freely. While constructivism is a common theory in early childhood education, it should be noted that the potential benefits of constructivist educational theories are not exclusive to young children.

Constructivism as a social learning paradigm may naturally affect all participants to some degree, including the teacher. Lambert (2003) utilizes constructivism as a theory to build professional development and professional learning communities. She uses the term “reciprocal processes of constructivist learning” to describe “learning that is mutual and interactive, thereby investing in the growth of all participants” (p.22). While she uses this as a means to explain the constructivist process in the professional development of teachers, I pose that this also applies to teachers during the lessons they teach. When a teacher plans and implements a lesson, the learning she experiences through successes and failures with lessons and students, alongside new information and experience that students bring to the table, forms another kind of learning by the teacher, a form of constructivism. In this way, the librarian's self-efficacy in teaching science may change as a result of planning and implementing constructivist science lessons.

Self-efficacy

Self-efficacy has been used for over 40 years to measure people's belief in their ability to cause change based on self-perceptions (Bandura, 1977). In Bandura's seminal article (1977) he explains the basis for Social Cognitive Theory, the overarching theory which includes self-efficacy.

> The present theory is based on the principal assumption that psychological procedures, whatever their form, serve as means of creating and strengthening expectations of personal efficacy. Within this analysis, efficacy expectations are distinguished from response outcome expectancies. An outcome expectancy is defined as a person's estimate that a given behavior will lead to certain outcomes. An efficacy expectation is the conviction that one can successfully execute the behavior required to produce the outcomes. Outcome and efficacy expectations are differentiated, because individuals can believe that a particular course of action will produce certain outcomes, but if they entertain serious doubts about whether they can perform the necessary activities such information does not influence their behavior (p.141).

As briefly addressed earlier in this chapter, the way a teacher (or librarian) believes they can or cannot perform a task, affects their ability to address those tasks, especially in a teacher developed and driven learning environment. As a result, I utilized this theoretical framework in an attempt to determine if experience with developing, planning, and implementing scientific inquiry lessons with her students, affected the school librarian's efficacy beliefs about teaching science.

Through these constructivist ideals, and the potential effect they have on the librarian's efficacy in teaching science, the school librarian and I developed lessons which allowed for both individual student-driven inquiry, as well as opportunities to collaborate with peers and ask questions from adults to propel students' personal areas of inquiry. In speaking about the self-fulfillment of the education of the child Montessori states, "And this opens the door to an imperious truth: the child is not an inert being who owes everything he can do to us as if he were an empty vessel that we have to fill" (p. 15). This assertation of student agency in their own learning experience is more fully examined through the learner-centered ideology.

Learner-Centered Curriculum Ideology

The learner-centered curricular ideology was built directly on these constructivist tenets and served as the cornerstone for the construction of the research study which follows in Chapter 3. Schiro (2013) explains that instruction in the learner-centered classroom is driven by student interest rather than a prescribed, step-by-step curriculum. But beyond the curricular aspect, it must be recognized that this is ultimately an ideology of teaching method. In the learner-centered classroom, "The teacher asks the students to make his decision because she believes that it is important for children to make choices about what they will learn and that the children have a right to direct their own learning" (p. 102). That is not to say the class, or the lesson is entirely student-driven. Lessons are still framed within an overarching curriculum and set of objectives, however, students can choose from highlighted activities within the learning objectives. "Educators must have objectives, but they must embed them in their curricula in such a way that learners' needs and desires always take priority over the teacher's objectives when the two come into conflict." (p. 125). However, it should be noted that "Learner Centered educators are much less interested in knowledge than they are in growth and learning." (p.118).

Expanding on the ideological aspect of this curricular framework, constructivist philosophies are inherent. “Learner Centered educators are not givers of knowledge, but rather givers of experiences out of which people will – with some degree of unpredictability – create knowledge for themselves” (Schiro, 2013, p. 119). Within this ideology, students represent individuals becoming, rather than bodies to teach, or test scores to record. They are people who are “conceptualized as self-activated makers of meaning, as actively self-propelled agents of their own growth, and not as passive organisms to be filled or molded by agents outside themselves.” (p. 115). This quote so closely matches Montessori’s that there can be little doubt that the learner-centered classroom would be the most appropriate environment to accommodate the constructivist philosophy.

These theoretical frameworks and curricular ideology dovetail with authentic science and library inquiry. The combination allows the student to identify and create their own line of inquiry and then for teachers and fellow students to work together through these individual inquiry processes by exploring the literature and experiential science activities. Through these constructivist/learner-centered lessons the diverse needs of students at differing levels of development, with different interests, and with different capabilities, can be met while simultaneously meeting learning objectives in both library and science instruction.

Conclusion

There are deficits in science achievement in the United States which appear to be present even in the early childhood classroom. National science standards and national library standards share common themes and ideas. In addition, the commonly accepted inquiry cycles in each discipline share similar practices and student learning goals. Both disciplines also face marginalization within the school. With all of these commonalities, perhaps it is time to evaluate the potential benefits of combining library instruction with science instruction to better support student learning. The school library may be a relatively unexplored place in the school where science may be naturally integrated with library skills in a manner that benefits student learning in both disciplines. This may be beneficial not only to the students, but also to teachers who may struggle with finding the time and the knowledge to effectively teach inquiry science in the classroom. By broadening our perspectives and ideas about what can be done in the school library, we may find the opportunity to support both disciplines in the school simultaneously, while also giving students a learning environment which can be tailored to their individual educational needs and interests. However, for this to occur, research has indicated that certain supports, such as dedicated planning time and mentorship, may be necessary. Additionally, the creation of lessons which combine both science and information inquiry through a cohesive inquiry cycle, and which addresses common national standards, may be necessary.

In Chapter 3, I present the research study developed to meet the common standards and goals in science and library instruction. I provide the framework and methodology for this study, in which I explored how a school librarian and an educational researcher worked collaboratively to create, develop, and implement the SSLIM curriculum; an information and science inquiry unit designed to support student learning in nature of science and scientific inquiry while simultaneously supporting library and information standards. I present the curriculum which we designed utilizing constructivist theories and the learner-centered ideology. I present the instruments that I used to measure student change in knowledge about NOS, SI, and ideas science and about who does science, through different modalities, including student drawings, small group interviews, and a science inquiry content test. I also present the measure used to examine change in the school librarian’s self-efficacy of teaching science over research study.

CHAPTER 3

METHODS

Through the exploration of the literature, I found many commonalities between school library science and science education. These included common language and student goals in national standards, common ideas and processes in inquiry cycles, as well as common goals and common challenges each discipline faces. I found that science education has long encouraged the use of trade books in science instruction and that research indicates that this inclusion can help to inform young students about science, as well as assist students in formulating correct ideas about science and scientists. Trade books should be carefully curated, as not all science trade books contain comprehensive or even correct scientific information, and not all sciences are equally represented in trade book literature. School librarians may be in the optimal position to assist science teachers in the curation of supplementary materials for science instruction. However, there may be a bidirectional lack of comfort and understanding between the science teacher and the school librarian, and while collaboration may be one way to overcome these misunderstandings, restrictive library schedules may inhibit regularly scheduled collaborations between school librarians and classroom teachers. Additionally, low efficacy in teaching science by both general education teachers and school librarians may further push this science collaboration aside. Finally, through the theoretical framework of constructivism and the learner-centered ideology, I explored a scenario where students may be the driving agents in their own line of inquiry, a concept that is encouraged in the national standards for both school library science and science education.

In Chapter 3, I will present an exploratory mixed methods case study conducted in one elementary school library. I presented a new inquiry cycle in the previous chapter which combined the BSCS 5E Inquiry cycle (Bybee, et al, 2006) commonly accepted in science instruction, with the Guided Inquiry cycle (Kuhlthau, Maniotes, Caspari, 2007; 2015), commonly accepted in information inquiry in the school library. I developed this new hybrid inquiry cycle to be utilized by students during the student inquiry lessons and it was operationalized through collaboration with the school librarian. In this chapter, I will present the methodology and the measurements used in the study. These include the structure and data analysis for the collaborative sessions in which the school librarian and I worked to develop the six-week information and science inquiry curriculum employing the new inquiry cycle as our framework. I will also present the data analysis procedures for analyzing the journals as well as the efficacy measurement used to measure any change in her science teaching efficacy. This is followed by the steps in the creation of the science inquiry content test, as well as the data analysis procedures for the other student measures used to determine student change in nature of science, scientific inquiry, and diversity of scientists. These are organized by each research question. Through these measures and the mixed-methods case study design, I will explore the different methods of data collection utilized to understand the larger picture of what happens when a school librarian and an educational researcher work together to support science and library instruction with second grade students. And how that implementation affects student learning in science and the librarian’s feelings about science, and science teaching efficacy.

Purpose

The purpose of this mixed-method, case study research was to explore the development of a Science in the School Library Inquiry Model (SSLIM) curriculum which leveraged the synergies between science and library instruction. In this study, I examined the collaborative development and implementation of a curriculum that supported second-grade student science learning in the areas of nature of science (NOS), scientific inquiry (SI), and the diversity of scientists, while simultaneously supporting information literacy through inquiry. I collected qualitative data through nine collaborative planning sessions and librarian and researcher journals. I examined the effects this curriculum development had on the school librarian's efficacy and feelings about teaching science. Additionally, I collected quantitative data in this study through three student measures: The Draw-A-Scientist Test (DAST), the Young Children's Views of Science (YCVS) protocol, and a science inquiry content test, as well as through one librarian measure, the Science Teacher Efficacy Belief Instrument (STEBI-B). The following research questions guided my data collection and analysis.

Research Questions

1) How do an elementary school librarian and an educational researcher, collaboratively plan and implement a learner-centered information and science inquiry curriculum for second-grade students in the school library?
2) How does the development and implementation of this curriculum affect the school librarian's feelings and self-efficacy of teaching science?
3) How do students' science content knowledge, perceptions about nature of science and scientific inquiry, and ideas about who does science change through information and scientific inquiry lessons in the school library?

I explored these research questions through both qualitative and quantitative data collection, gathered during a case study methodology that incorporated a variety of instruments and measures. Due to the complexity of the mixture of measures and the ways they are analyzed, the body of this chapter will be organized by the research questions and the methods used to answer them.

Research Design

I chose a case study design because I was interested in acquiring a detailed look into many different aspects of this research study. I wanted to examine the process of the creation of the curriculum, the feelings and perceptions of the librarian through this process and how they affected her science teaching efficacy, as well as how the students responded to the Science in the School Library Inquiry Model (SSLIM) curriculum and how it affected their ideas about nature of science (NOS), scientific inquiry (SI), and their ideas about science and scientists. Because I wanted an in-depth look into these multiple aspects of one small sample of individuals within one school and in one setting, a case study design was most appropriate. "The defining characteristic of case study research lies in delimiting the object of the study, the case…the case as a thing, a single entity, a unit around which there are boundaries" (Merriam, 2001, p.27). In this case, the "unit" is the school librarian and her second-grade students in the school library during approximately four months of planning and instruction.

I also wanted to gain insight into the collaborative process when creating a new curriculum. Merriam states, "Case study is a particularly suitable design if you are interested in process" (Merriam, 2001, p.33). Additionally, I was interested in the librarian's thoughts and feelings, as reported through her journals during this research study, and if those thoughts and feelings affected her self-efficacy in teaching science. I determined the STEBI-B could provide data to inform potential changes in her self-efficacy and could be used as a pretest/posttest measure, providing quantitative support to my qualitative analysis of her journals. Creswell (2015) states "…when an investigator combines statistical trends (quantitative data) with stories and personal experiences (qualitative data) this collective strength provides a better understanding of the research problem than either form of data alone" (p. 2). Finally, I wanted to look at student changes using statistical analysis which also uses a variety of data sources (science inquiry content test, drawings, and small group interviews). Merriam (2001) states “Any and all methods of gathering data, from testing to interviewing, can be used in a case study…” (p. 28). Because of these factors I chose the case study research design, as it allowed me to comprehensively examine the multiple aspects of my study to answer my diverse research questions and gain insight into the process as a whole. Through the mixed-methods case study research design I was able to investigate the process of creating the curriculum through collaboration, gain insight into the daily life of the school librarian and her students, identify the necessary supports, examine the effects of this curriculum on the school librarian’s science teaching efficacy, and measure student growth of concepts and ideas about science.

This case study was multifaceted, with three research questions, two of which incorporated multiple data sources. In the first research question I examined the process of developing a novel, collaboratively created and implemented, science and information inquiry curriculum, structured around the Science in the School Library Inquiry Model (SSLIM). During the development of the SSLIM curriculum, we utilized the Science in the Library Inquiry Model as a framework in developing learner-centered lessons which incorporated both information inquiry and science inquiry in one comprehensive student inquiry cycle. This cycle would allow students to move between textual information about their topics found in non-fiction resources, such as trade books, and experiential science stations at their own pace and to meet their personal inquiry needs. In the second research question I examined how that curriculum development and implementation affected the school librarian’s feelings about science and her self-efficacy in teaching science. I did this by analyzing journals and expressions of feelings within those journals, along with the Science Teacher Efficacy Belief Instrument

(STEBI-B) which was utilized as a pretest and posttest measure. In the third research question I examined how this curriculum affected the students' ideas about nature of science (NOS), scientific inquiry (SI), and the diversity of science and scientists. For this question I utilized three separate instruments to measure student change in mean scores from pretest to posttest. Because of all the different types of questions I wanted to investigate, mixed methods case study was the most suitable research design.

Bounding

I bounded this study by one grade level (second-grade), within one elementary school, with one school librarian, (primarily) in the library, within one school semester. I looked at a limited sample within the second-grade of 32 students, consisting of 16 female students and 16 male students. The K-5 elementary school in this study was located in a suburban school district, in a Mid-Atlantic state.

Participants

In this research study I look at two separate but interlinked participant groups: the elementary school librarian (*n* = 1), and a sample of the students from the four, second-grade classes (*n*=32) at Parks Elementary School (pseudonym).

Librarian

There were three primary criteria for the purposive selection of the elementary school librarian for this study. The librarian needed to be actively interested in participating in science lesson creation and implementation, was not already teaching extensive amounts of science in her library, and was willing to be flexible with her teaching schedule and lessons. Before the implementation of this study, I met with the library administrator for the school system who identified four potential candidates within the elementary school population. Based on these selection criteria we determined Sarah (pseudonym) was the best candidate. Sarah was willing to participate in the study, she was new to school librarianship, she was not extensively teaching science, and she was willing to implement and try new science lessons.

When I first made contact, Sarah was beginning her second year as the Park's Elementary School librarian. Sarah was previously a first-grade teacher for six years, making her familiar with the different content standards for elementary grade levels. While she taught science lessons during her classroom years, Sarah, herself, voiced unease with science instruction. Because one aspiration of this study was to see how this type of curriculum could be implemented with a librarian at any comfort level, her lower confidence made her an ideal fit.

Sarah was the sole full-time librarian at her school. There was also a library assistant who worked Wednesdays, Fridays, and every other Thursday. As a result, Sarah relied heavily on parent volunteers to assist with book check-out and re-shelving while she taught classes.

Students

I chose second grade for this study because, while disengagement with science may happen as early as Kindergarten (Patrick, Mantzicopoulos, & Samarapungavan, 2008), my research necessitated a slightly older aged student. Students needed to be able to create their own question, independently search for and record information in books or online, and record experiential findings in their journals. This made second grade the most ideal grade level within the early-childhood ages.

We issued all second-grade students *Parental Consent* forms (Appendix A) before the study began. We also offered students an incentive of five "School Bucks" for returning the parental consent forms, either approving or denying participation in the study. Students who asked for additional parental consent forms were provided with those by Sarah or myself. I also provided students with assent forms, which I read aloud, before beginning the first lesson. I included all students who returned approved parental consent forms and also personally assented to participate in the research study. Only one student who provided parental consent denied personal assent. This resulted in a sample of 32 students from the second grade, 16 girls and 16 boys.

It should be noted that approximately two weeks into planning, it was brought to my attention that only about 50% of the second-grade students received science instruction in this school. Science and social studies were considered “enrichment” for students who were proficient in reading and mathematics. The remaining 50% of students received remediation during that time. Unfortunately, I did not know that half of the students were not receiving science instruction prior to submitting my application to the school system, and while that information may have been very useful to this study, I was denied access to that portion of student data about my participants when I later requested it.

Gaining Access to the Setting

Creswell (1998) identifies qualitative measures as those in which the investigator “labors over field issues of trying to gain access, rapport, and an “insider” perspective” (p. 16). With this in mind, I began to insert myself into the school and the school library community well before the beginning of the research study in an effort to both become personally comfortable within the school, and more importantly, for the school librarian, the administration, the teachers, and the parents to become more familiar and comfortable with me.

The first meeting between Sarah and I was a casual meeting at a restaurant after work on a Friday in the fall of 2016. We discussed what the research study was going to look like, her anticipations and reservations, and ways we could work through planning and implementing lessons. I also inquired about volunteering opportunities I could participate in. The first volunteering opportunity I participated in was at the school Fall Festival. I volunteered for four hours, the entire duration of the festival. After the festival was over, Sarah brought me into the library to look around. We talked primarily about the layout and the scheduling of the library lessons.

The next volunteering opportunity was the fall library book fair. I volunteered for a total of 12 hours, assisting with set up the Friday before, helping with students during the week, and packing it up at the end. During these volunteer sessions, I became acquainted with the library assistant and several of the mothers that volunteered in the library. These volunteering opportunities also afforded me the opportunity to meet some of the parents of the second-grade students I would be working with.

Throughout the research process, I stayed late to help with checkout and re-shelving when possible. I also volunteered at the spring book fair. However, by this time, close to the end of the end of the study, my impetus had shifted from “gaining access” to helping Sarah in an attempt to alleviate some of the strain my research had caused her.

Setting

School

Parks Elementary School was nested in a suburban neighborhood, in a Mid-Atlantic state. It was a smaller elementary school compared to neighboring elementary schools with a student population of 502 students, 236 girls, 266 boys. During the time of this research study, Parks served kindergarten through fifth-grade students. Student demographics for the school compared with the school division for the 2016-2017 school year can be found in the following table (Table 7).

Table 7

Comparison of School System to School Demographics

	School Division Statistics	Parks Elementary School
Total	29805	502
Female	14594 (49.0%)	236 (47%)
Male	15211 (51.0%)	266 (53 %)
Asian	740 (2.5%)	TS
Black	15884 (53.3%)	189 (37.6%)
Hawaiian / Pac Islander	86 (0.3%)	TS
Hispanic	3752 (12.6%)	TS
Multi-race	1708 (5.7%)	50 (10%)
Native American	90 (0.3%)	TS
White	7545 (25.3%)	218 (43%)
Special Education:	3957 (13.3%)	TS
Economically Disadvantaged	18652 (62.6%)	262 (52.2%)

TS= indicates a number too small to report due to identifiable student regulations (FERPA).

Library

The inquiry lessons for this research study took place (primarily) in the school library. The school library was in a central location in the school, located on the main entrance hall across from the main office. It had six large student tables with the capacity to seat 36 students, an instructional area with a reading carpet, a small student reading area with a sofa, and six (five working) student computers (Figure 2).

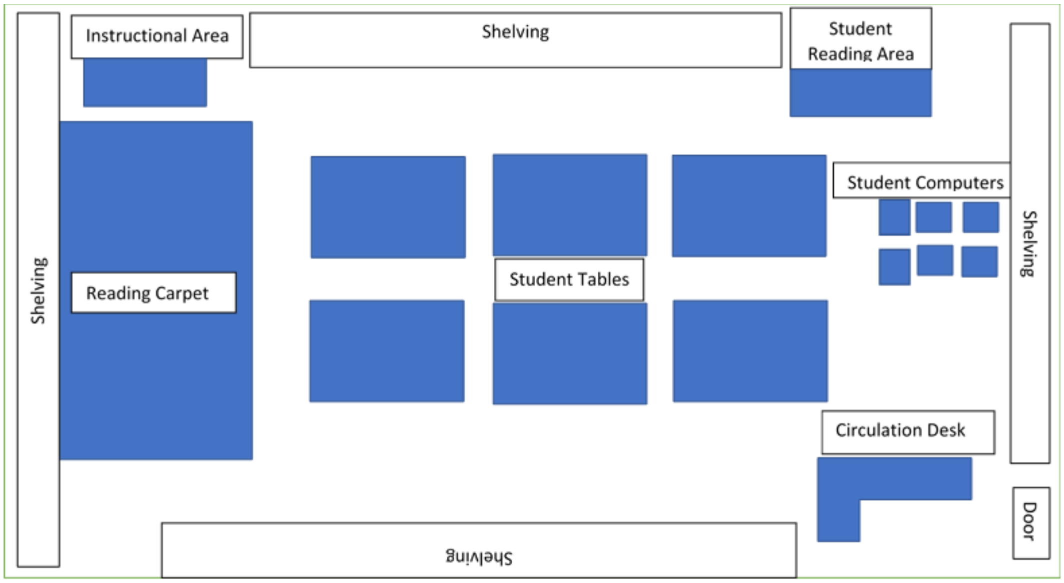

Figure 2. Park's elementary school library layout

The school was undergoing regular repairs on the roof throughout this research study. Overall, this construction caused minimal disruptions to the library lessons but did result in displacement from the library for over a week at the beginning of the study due to the main office flooding. This flooding resulted in the relocation of the office and nursing staff to the library which, in turn, resulted in the library being closed to students and teachers. During this displacement, the science and information inquiry lessons were taught in the classrooms, during the scheduled library times.

The science planning sessions also took place (primarily) in the school library. The nine collaborative planning sessions varied in time and were scheduled around openings in Sarah's schedule. Comprehensive information about the times, topics, and findings of these collaborative sessions can be found in Chapter 4. The fixed-library schedule is a component in the setting of these lessons and this research study. As a result, the pretests, posttests, and student inquiry lessons were scheduled once a week for approximately 45 minutes per class, over the course of 14 weeks. In this particular school, the librarian and the guidance counselor overlapped in some of the scheduled resource times, resulting in two gaps in the scheduled library instructional times, when the guidance counselor had the second grade classes. The spring book fair also interrupted instruction for one week, as did spring break. As a result, the lessons were continuous throughout the research time span, but not necessarily conducted every week. Based on this schedule we created 10 total lessons, with four lessons dedicated to pretests and posttests, and six lessons dedicated to the Science in the School Inquiry Model (SSLIM) curriculum. A comprehensive table with dates, activities, and materials can be found in Table 14, in Chapter 4.

The Science in the School Library Inquiry Model (SSLIM) described in Chapter 2 served as the foundation and structure in developing the science lessons and the curriculum. Using this new inquiry cycle as a foundation to the lessons, Sarah and I collaboratively built science lessons that introduced our concepts utilizing science literature as an introduction. In this model, students were encouraged to develop their own individual questions (Enquire), conduct preliminary informational research (Inquire: Library) and explore experiential stations (Inquire: Science). They could then move fluidly between the phases and stations as they chose. This allowed for revising questions or lines of inquiry and revisiting stations and resources as the students needed.

In order to analyze the effectiveness of this new inquiry cycle and the curriculum development as a whole, I utilized both qualitative and quantitative data analysis. Through the different data analyses I was able to examine the collaborative development of the curriculum, the school librarian's thoughts and feelings recorded in her journals, my own notations in my researcher journals, the school librarian's efficacy beliefs in teaching science, and the student perceptions of nature of science, scientific inquiry, and the diversity of science and scientists. In the following section I address the means for collecting and analyzing these data, which are organized by research question.

Measures

In this research study, I employed a range of measures and instruments. The following table (Table 8) provides an overview of the methods and instruments I used for gathering and analyzing data for each research question. The section following this table will further explain the quantitative and qualitative measures used. Because I utilized various types of instruments and data collection, these measures will be organized by research question.

Data Collection

Table 8

Crosswalk of Research Questions with Data Sources and Analysis

Research Question	Data Source	Analysis
1) How do an elementary school librarian and an educational researcher, collaboratively plan and implement a learner-centered information and science inquiry curriculum for second-grade students in the school library?	Transcriptions of nine collaborative sessions. 555.4 minutes or approximately 9 hrs. and 15 minutes.	Deductive coding using Kimmel's (2012) codes collaboration, with modifications.
2) How does the development and implementation of this curriculum affect the school librarian's feelings and self-efficacy of teaching science?	STEBI-B pretest and posttest librarian journal, researcher journal	STEBI-B: Paired sample *t* test and independent sample *t* test; journals: open thematic coding, cross-analysis
3) How do students' science content knowledge, perceptions about nature of science and scientific inquiry, and ideas about who does science change through information and scientific inquiry lessons in the school library?	Science inquiry content test, Draw-A-Scientist Young Children's Views of Science	All instruments (science inquiry content test, DAST, YCVS) analyzed through paired sample *t* tests and independent sample *t* tests.

Timeline

The following chart provides a brief timeline of the implementation of the different aspects of the research study (Table 9).

Table 9

Gantt Chart

GANTT CHART	Jan.	Feb.	March	April	May	June	July(+)
STEBI-B pretest	🟦						
Plan with librarian	🟩	🟩	🟩	🟩			
SI content test, YCVS, DAST Pretests		🟧					
Science lessons in the library		🟨	🟨	🟨			
SI content test, YCVS, DAST Posttest					🟧		
STEBI-B posttest					🟦		
Data Analysis						🟩	🟩

Data collection and planning took place over a five-month span of time, in which I was an active participant-researcher, a mentor, and collaborator. Due to last minute changes in research study, I also became a co-teacher in the lessons (there is more about this in Ethical Considerations section later in this chapter.) During this time, I had the unique opportunity to embed myself into the culture of the library and when possible, the school at large. This afforded me insight into multiple aspects of this library program and to gain first-hand experience into the implementation of the information and science inquiry lessons with the students by becoming a participant myself. It should be noted that the student pretests took place in the first weeks of February, but that the inquiry lessons did not begin until the end of February when the pretests were complete. In this way, they appear to overlap in the timeline, but in reality, they did not.

Research Question 1

How do an elementary school librarian and an educational researcher, collaboratively plan and implement a learner-centered information and science inquiry curriculum for second-grade students in the school library?

Overview of Collaborative Sessions

I recorded and later transcribed all formal collaborative planning sessions. This resulted in transcripts for nine planning sessions which ranged from about thirty minutes to about two and a half hours, depending on Sarah's planning schedule for the day, as well as the planning that needed to be covered for upcoming lessons. Some days consisted of short, interval planning sessions, while others were long sessions of planning and developing materials. When complied, this produced in a total of 555 minutes and four seconds or just over nine and a quarter hours of formal collaborative planning sessions. This does not include the informal planning that happened naturally during casual discussions or during lesson times. I limited all collaborative sessions to school day planning times.

Analysis of Collaborative Sessions

I transcribed and coded every word from all collaborative sessions using a deductive coding structure established by Kimmel (2012). Kimmel's research was inductive and examined the processes of collaborative planning sessions with the school librarian and a team of second-grade teachers, over the course of one school year. This research resulted in five major categories and phases of planning: *Orienting, Coordinating, Drifting, Making Sense,* and *Making Connections*. Because of the nature of my collaboration with Sarah, and the grade of the students involved, I felt this was the most appropriate method of coding for our collaboration sessions.

Because this research is similar to Kimmel's in the collaborative nature but different in that we were building a novel curriculum in an unknown format, there were additions and alterations to Kimmel's codes. These are described in the following table (Table 10).

Table 10

Interpretation and Application of Collaborative Codes

Code	**Kimmel definition**	**How I applied codes**
Orienting:	Setting agendas, making decisions, checking in, getting back to topic	What are we talking about now/today, getting back on topic after interruption or drifting, changing topics of planning
Coordinating:	Aligning schedules to share resources, students, or activities	Scheduling what to do when (scheduling lessons /test), scheduling around other obligations/holidays (guidance, book fair, spring break) moving classes around, the logistics of managing resources for lessons (set-up, breakdown, managing existing materials), coordinating interview groups, establishing who does what
Making Sense:	Understanding curriculum, teaching, resources, or student learning (understanding)	Identifying NOS, SI, State Standards, school procedures, research procedures and materials (pre/post-tests)
Making Connections:	Connecting curriculum to resources, other curricula, or past experiences	Advanced planning across multiple standards and goals, ordering and organizing resources (books/science equipment) for lessons, discussions about altering texts/tests for time, talk about stations, development of science inquiry content test
Drifting:	Any "other" talk that led away from the planning agenda, student behavior	Talk about anything not related to lessons: i.e. feelings, personal information, personal delays.
Talk about Learners	New code	Consent/Assent forms, discussion about altering activities based on popularity, planning based on student input, explicit talk about specific students including behavior

While Orienting and Drifting were well aligned with Kimmel's definitions, I found that since we were creating a new curriculum rather than utilizing an existing curriculum, there were some differences in the ways that I coded Coordinating, Making Sense, and Making Connections. Because Kimmel planned with a grade level that was sharing resources, Coordinating was the code used in the scheduling of sharing of resources. However, the nature of our collaboration did not necessitate sharing resources with others, so Coordinating became more heavily tied to scheduling (coordinating) the timeline of the lessons, rescheduling (coordinating) conflicts and moving classes, and the management (coordinating) of existing materials, including set-up/breakdown, storage, etc.

Making Sense was heavily tied to explaining previous knowledge to each other, which we were not already familiar with. This was, quite literally, us making sense of unknowns in the setting and study and explaining them to each other. This resulted in a more extensive amount of time in the initial planning sessions spent on Making Sense where Sarah explained schedules and school procedures to me, and where I explained nature of science and scientific inquiry to her.

Making Connections was when we connected our goals to larger standards, selected appropriate materials, created activities, and created and/or altered student measurements. This was the code that felt like the "meat" of the planning. It was also utilized for coding "ah-ha" moments and times when we tied everything together to hit multiple goals.

I also applied an additional code of Talk about Learners. Kimmel incorporated talk about students (learners) into multiple categories: student discipline was in Drifting, student learning was in Making Sense, and scheduling with students was in Coordinating. However, in this study students were, in a way, members in our planning sessions, as much of our collaboration and planning was directly tied to students returning parental consent forms, turning in personal assent forms, their choices in stations, and their voice in actively choosing the final lesson in the unit. Because this curriculum was so heavily designed around the learner-centered environment, I felt it was important to code for those participants within the collaboration and planning as they were active, albeit not present, planners and participants in the creation of the study. This code included explicit talk about students as well as implied student participation such as adjusting stations based on student participation or interest, and during the planning of the student choice inquiry lesson.

The following table (Table 11) gives examples from our collaborative sessions to further clarify how I applied the categories to my own research.

Table 11

Collaborative Coding Examples

Kimmel (2012) collaborative codes	Examples
Orienting	B: So, some of the things we need to do today are the Draw-A-Scientist, and this other one that's called the Young Children's Views of Science.
Coordinating	B: Okay, so then we are on to week five, right? S: Mmm hmm. Through 3/23.
Drifting	S: Are you staying here or are you done? B: I have to go because I have to get my kids off the bus.
Making Sense	B: What does that mean they have a Free Day? S: So, it's part of the behavioral system. They have five questions that we ask…"
Making Connections	S: I'm just looking at third grade [standardized testing standards] to see what they have. Plants, animals, and they do have energy, soil, water, moon phases, human impact on the Earth, motion, energy, simple machines…but that's not until the end of third grade…
Talk about Students	B: But they are second grade. They know about science. Because [the students] I talked to the other day were… S: They are probably higher than the rest of the class.

Twenty percent (approximately 22 pages) of transcripts were selected for review by two educational specialists to verify coding validity. These sections were randomly selected by the educational specialists, and resulted in an 89% inter-rater reliability rate. As a result, there were no further adjustments made to the coding structure, and data analysis (located in Chapter 4) began.

Research Question 2

How does the development and implementation of this curriculum affect the school librarian's feelings and self-efficacy of teaching science?

I addressed this research question using both qualitative and quantitative measures. I conducted open-coding, qualitative analyses of librarian and researcher journals, which were kept throughout the majority of the research study. In addition, before the study began and after it was completed, I administered the Science Teacher Efficacy Belief Instrument (STEBI-B), as a pretest/posttest measure to examine any changes to Sarah's self-efficacy beliefs in teaching science.

Science Teacher Efficacy Belief Instrument (STEBI-B)

The source of the quantitative data was the Science Teacher Efficacy Belief Instrument (STEBI-B). The STEBI-B is a 25 question, five-point, Likert-type scale developed to measure the science efficacy of practicing general education elementary teachers (Appendix B). I administered this before any collaboration took place, and again after the completion of all inquiry lessons. I used it as a means to measure any self-reported changes in Sarah's science teaching efficacy beliefs over the course of the study and to determine if the development and implementation of the SSLIM curriculum had any effect on her science teaching efficacy. I analyzed this using a paired sample *t* test to determine if there were any statistically significant changes to the mean scores of the total instrument, and then used independent sample *t* test, to determine if any change was seen to efficacy belief or outcome expectancy, separately. More information about these scales follow.

About the STEBI-B. The Science Teacher Efficacy Belief Instrument (STEBI-B) was developed by Riggs and Enoch (1990) to address the science efficacy beliefs and science teaching outcome expectancies of practicing elementary school teachers. The rationale for developing this instrument was to evaluate teachers' priority levels in teaching science and as a means to address potential reasons for why teaching science is often avoided in the elementary school classroom. Riggs and Enoch (1990) assert that addressing teacher efficacy beliefs and outcome expectancies in teaching science, especially in the elementary school classroom, is essential to addressing this lag in science instruction and competencies. Though other teacher efficacy scales existed, the researchers felt that an instrument designed specifically around science instruction was necessary, as a teacher's overall efficacy beliefs may not mirror their science teaching efficacy beliefs. In addition, their research was focused on elementary school teachers due to the stated importance of student exposure to science in the formative years of education. One relevant area to consider is the age of this instrument. Since it was built around measures and efficacy beliefs in 1989 this instrument may have lost some validity. Teachers today may not have the same self-efficacy beliefs and outcome beliefs or respond to the wording of the survey in the same way as they did 30 years ago. However, it should be noted that these same instructional gaps in teaching science exist in the modern elementary school classroom and continue to be studied, evaluated, and reported today thus making the general research topic presently valid.

The STEBI-B scales were modeled after the scales designed by Gibson & Dembo (1984), designed to measure teachers' self-efficacy and outcome expectancy beliefs in education in general. Riggs and Enoch modified and reworded the measurement to explicitly include elementary science terms and questions. The instrument is a five-point Likert-type scale ranging from “Strongly Agree” to “Strongly Disagree.” There is a combination of both positive and negative statements in the questionnaire. The resulting instrument is comprised of two scales: The Personal Science Teaching Efficacy Belief scale and the Science Teaching Outcome Expectancy scale.

Journals

Librarian Journals. I asked Sarah to keep a daily science teaching journal where she recorded her account of the day, her feelings about the process and the lessons, as well as any notes about planning or discussions with myself or other teachers as it related to the research. She agreed that starting with the first student pretest lesson (February 6th) and following each subsequent lesson, she would reflect in a journal entry about what she felt, what she thought had worked or didn’t work, or could be changed for the next lesson, etc. Sarah missed some journal entries due to being overwhelmed, tired, or sick. As a result, a couple of weeks were combined into longer week-long reviews of the lessons. Toward the end of the research study, she expressed that she had been too overwhelmed to complete the journals, at which time we discontinued them for her. As a result, her last journal entry is April 19th where mine continued until May 1st.

Researcher Journals. I actively participated in all second-grade information and science inquiry lessons. Due to this active participation, my field notes were primarily recorded in journal format during the afternoon or evenings following the lessons. These notes included my personal feelings about the lessons, informal planning notes that were not recorded in official planning sessions, things students said to me during the lessons, my observations about barriers that Sarah faced, statements she directly voiced about the lessons or her barriers, and the interactions with others (administrators, teachers, volunteers) that affected or interacted with the lessons and/or planning sessions.

Analysis

I utilized open, thematic, coding to determine common themes from both journals. I began by reading through all journal entries in their entirety to begin to form initial categories of codes. The five preliminary, or root categories were: notes on planning lessons, notes on implementing lessons, barriers faced, supports needed, and miscellaneous. As coding progressed, I altered and expanded these main categories to include more specific categories. During this next phase, I established six root codes: notes on planning lessons, notes on implementing lessons, barriers faced, supports needed, talk about students, and miscellaneous. However, the barriers faced were so abundant and varied that I established eight additional sub-codes of barriers. These were: displacement, lacking resources, time constraints, scheduling issues, other obligations, feeling tired, feeling uncertain, feeling frustrated. I eventually re-evaluated these codes and condensed them during the cross-coding phase.

I independently coded each journal using the same code set. I coded every word in every entry. The following table (Table 12) provides the main codes (left column), the sub-codes, the meanings and examples from the initial code set. This was the document presented to the educational expert panel to verify codes, which resulted in a final inter-rater reliability of 91%.

Table 12

Initial Journal Coding Key

Code	Subcodes	Meaning	Examples
*Barriers Obstacles to overcome	Displacement	Moved out of the library	For flooding, testing, out of the library and/or in classrooms
	Lacking Resources	Things that were needed but not available	Books, science equipment, supports that were needed but not present
	Other Obligations	Obligations that impacted the scheduling and/or teaching of classes	Personal, family, SCA, hall duty, book fair, lunch duty
	Scheduling	Scheduling classes	Basic statements about scheduling classes, changing class times, switching classes around, problems with scheduling, etc.
	Time Constraints	Problems with fitting everything in	Rushing, expressed feelings of time pressures, when lessons were cut short, not being able to fit in all lesson ideas, etc.
	Tired	Statement of being tired	Mostly explicitly stated, occasionally implied tiredness
	Uncertainty	Not understanding what is required	Worry, feelings about not knowing or understanding what is expected, not understanding school procedures, or how someone will respond.
	Frustration	Expressed negative feelings about lessons or time	Feeling stressed out, explicit frustration, anger, expression of being overwhelmed.
*Implement Lessons		Talk about how lessons were implemented	Step by step explanations of lessons, “I did” / “We did”
*Plan Lessons		Talk about planning	Planning both formally and informally, often explicitly preceded by “we plan(ed) to” but also implied right before lessons, planning for the next day’s lesson
*Students		Any talk about students	Includes students, classes, “they”
*Supports Needed		Materials/personnel necessary to carry out lessons	Any materials needed to do lessons (books and science), Instances where I taught, instances where I bought/brought material, set-up/breakdown, times when I helped in the library – things that a person would need to recreate the research.
*Misc.		Positive feeling, uncategorizable statements, Researcher Notes in journal	Feelings about how the lessons went (generally positive), feelings about students, statements about arrival times (etc.), all notes-to-self.

I analyzed the journals individually, as well as collectively, to compare our individual perceptions as well as compared the shared perceptions of the development and implementation of the curriculum. In some instances, a single sentence could contain multiple codes. For example, an entry in Sarah's journal read,

> […we are using a lot of time to set up] [and I am not able to do as much with the lessons because I am managing the checkout station.] (3/1/2017)

In this entry, Sarah was explaining how she was checking out books from a laptop and a cart of books in the classroom due to the displacement from the library. This took away from her participation in the actual lesson since this process was time-consuming and there was no volunteer or library assistant there to do it, as there would have been in the library. As a result, I coded the beginning portion for Time Constraint and the second portion for Displacement. In this way, I coded every thought segment by topic, not by line, or sentence. Conversely, my application of a code by a whole thought segment, often resulted in multiple sentences within one coded segment.

Inter-rater Analysis. Two educational specialists randomly selected 20% of our journal entries which they then coded using Initial Journal Coding Key (Table 12), along with a brief explanation about root and sub-categories. The initial analysis of codes resulted in an inter-rater reliability of 86%. During the discussion that followed with the panel and I, we discovered that while most segments were generally coded the same, the highest rate of disagreement was with the codes of Tired, Uncertain, and Frustrated. After more discussion, we determined that these were all feelings associated with being overwhelmed, and thus were combined into one code: Feeling Overwhelmed. This consolidation brought the inter-rater reliability up to 91%. Also, while there was little dispute about coding for Planning Lessons and Implementing Lessons, we decided that for this portion of the study there was little reason to differentiate between the two.

As a result, those root codes were collapsed into one root code renamed Planning and Implementing Lessons.

Through cross-coding, five main themes emerged. These themes were: Talk About Students, Feelings, Planning and Implementing Lessons, Problems with Time, and Supports Needed. Again, because students were such a large portion of this research study, I maintained a code dedicated to any talk about students. I also discovered during cross coding, that much of the previous Miscellaneous category contained positive feelings expressed. As a result, these feelings were sorted out of Miscellaneous and combined with Feeling Overwhelmed to produce the main code of Feelings. The remainder of excerpts in the Miscellaneous code were sorted out into the most appropriate main codes. Planning and Implementing Lessons remained an independent code. Other Obligations, Time Constraints, and Scheduling were all collapsed into a main code of Problems with Time. Displacement and Lacking Resources were collapsed into the main code of Supports Needed.

Research Question 3

How do students' science content knowledge, perceptions about nature of science and scientific inquiry, and ideas about who does science change through information and scientific inquiry lessons in the school library?

This research question was examined using three pretest and posttest measures which were analyzed through quantitative analyses of paired sample *t* tests for whole group analysis, and independent sample *t* tests for analysis by gender. These measures were the Draw-A-Scientist Test (DAST), the Young Children's Views of Science (YCVS), and a science inquiry content test that was designed by Sarah and I.

Draw-A-Scientist-Test

The Draw-A-Scientist Test (DAST) has been used for nearly 25 years, in various countries globally (Narayan, Soonhye, Peker, & Jeekyung, 2013) to determine student perceptions about scientists. The DAST was created by Chambers (1983) to better determine the preconceived stereotypical notions of younger students about scientists. While research had previously been conducted by Mead and Metraux (1957) with adolescent and older aged students, these measures elicited response through essays. Chambers modified this study to examine the earliest age that students begin to exhibit these stereotypical images of scientists by utilizing drawing as a means to measure the imagery of very young students. The DAST was originally administered to 4,807 students in grades K-5 in the United States, Canada, and Australia. Based on the results from Mead and Metraux, Chambers established the following seven indicators of "the standard image of a scientist" (p. 258)

(1) Lab coat (usually but not necessarily white).

(2) Eyeglasses

(3) Facial growth of hair (including beards, mustaches, or abnormally long sideburns).

(4) Symbols of research: scientific instruments and laboratory equipment of any kind.

(5) Symbols of knowledge: principally books and filing cabinets.

(6) Technology: the "products" of science.

(7) Relevant captions: formulae, taxonomic classification, the "eureka"! syndrome, etc.

Finson, Beaver, & Crandon (1995) built on Chambers' research to create a streamlined means to quantify results for statistical analysis. They utilized the existing traits in Chambers' research and also added categories to include alternate images discovered by Chambers. Additionally, they added a category about the ethnicity of the scientist drawn. The additional indicators were (p.199):

8. Male Gender
9. Caucasian
10. Indication of Danger
11. Presence of Light Bulbs
12. Mythical Stereotypes (Frankenstein creatures, Jekyll/Hyde figures, “Mad/Crazed”)
13. Indications of Secrecy (signs or warnings of “Private,” “Keep Out,” “Do Not Enter,” “Go Away,” “Top Secret,” etc.)
14. Scientist Doing Work Indoors
15. Middle Aged or Elderly Scientist

In this new measure, the Draw-A-Scientist Checklist (DAST-C), Finson, Beaver and Crandon quantified the categories using a binary method of scoring. They did this by assigning a 1 or a 0 to each category or stereotype, with a maximum score of 1 for each category or a 0 for the absence of that category/stereotype. The total number was then added, with a higher score indicating more stereotypical images present. Finson, Beaver and Crandon also suggest the use of the DAST-C instrument as a means to measure change in student perceptions as a pretest and a posttest to measure of the effectiveness of a science instructional intervention. The complete instrument can be found in Appendix C.

I utilized the Draw-A-Scientist Test (DAST) to measure changes in students’ ideas about who does science and to the DAST-C to quantify it into a pretest/posttest measure. Sarah and I administered the DAST to all students as the first measure (prior to any science lessons) and then again after completion of all science lessons. We provided students with a blank sheet of computer paper, access to drawing and coloring materials, and gave them 10 minutes to “draw a scientist.” We administered the pretest in the library, however, due to the library being used for state standardized testing, we administered the posttest in the classrooms. A sample of pretest and posttest student drawings were scored and verified by two educational experts with a 95% agreement with my scoring. I then analyzed the scores using a paired sample *t*-test on the whole group, then an independent sample *t*-test to examine any difference by gender.

Science Inquiry Content Test

Another aspect of this research question was to determine the growth of the students in the science inquiry content areas being taught. I did this by administering a science inquiry content test to the students, which was collaboratively created by Sarah and I. This science inquiry content test was administered as a pretest/posttest measure. During the initial phase of development, we both agreed that the test needed to be short and easy to understand. As a result, we chose a multiple-choice format. We then began to develop our blueprint by identifying all of the concepts we would like to see covered in the test. These fell into three major categories: different types of scientists (diversity in science), where science happens (scientific inquiry), means of conducting science (nature of science), with one question based on magnets which was originally intended to be tied directly to a single lesson on magnets. We eventually removed this question from the post-test and subsequently, was removed from all analyses. The finalized pretest blueprint can be found below, in Table 13. These categories of information were chosen to reflect the scientific inquiry (SI) and nature of science (NOS) topics we planned to teach during the lessons, as well as measure students' ideas of the diversity of scientists and types of science. We designed this test with the intent to measure these core ideas both before and after the information and science inquiry instruction. Because we designed it to simply measure any change in student ideas of science and scientists, questions were created to only measure recall of knowledge. As a result, we did not address higher levels of Bloom's taxonomy in this test. We also later decided that because students had received instruction in the classroom setting about magnets, that question should be removed from the post-test and from all data analysis, as to reduce that as a confounding factor in the results.

Table 13

Science Inquiry Content Test Blueprint

Content Outline	Content Question	Knowledge	Total Points	% Pre-test	% Post-test
Different Types of Science/ Scientists	Q2, Q5; Q7; Q 10	Identify that scientists are different genders, backgrounds, and ability levels; there are distinctly different areas of science. (diversity in science)	4	36 %	40 %
Where Science Happens	Q 4, Q, 8	Identify that science can happen in various setting. (scientific inquiry)	2	18%	20%
Means of Conducting Science	Q1, Q 3, Q9, Q 11	Identify that there are different tools and methods of conducting science depending on the type of science. (nature of science)	4	36%	40%
Magnets (removed from post-test)	Q 6	Magnetic properties and uses in science	1	10%	N/A
Total				100%	100%

We revisited and revised questions until clarity of meaning and wording of the questions was agreed upon by both of us. Once we were satisfied with the questions, the instrument was sent to two education experts for review of question integrity. Both reviewers agreed with the appropriateness of the questions and the level of terminology used for the age of the students in this study. Finally, the questions were administered to two children (aged 8) for clarity of questions and as a means to pilot the measurement. No further need for revisions was warranted.

All students present in all four classes participated in the pretest and posttest. For this measure we set up testing barriers to prevent students from sharing information. Either Sarah or I verbally read each question and all possible answers to that question, twice, while the students took the test with paper and pencil at their own seat. We also projected the questions on a screen to assist students with visual disabilities and/or reading disabilities. The pretest consisted of 11 multiple-choice questions, however, the question about magnets was removed from the test, resulting in 10 questions for the posttest. We did not directly discuss any items on the test or the scoring with the students, in an attempt to reduce testing effect. After completion of all of the science lessons in this study, we re-administered the same test (minus the magnet question) to all students in all classes to determine changes in scores on the tested science content. The complete pretest is located in Appendix D, with the revised posttest in Appendix E.

The original student sample was *n*=32, however, one student was absent for the pretest, and was therefore not included in the data analysis. This resulted in a sample of *n*=31, with 15 male students and 16 female students represented in the sample. Due to scheduling constraints, an alternate time for testing the absent student was not possible.

I conducted an Item Analysis for the Item Difficulty Index and the Item Discrimination Index. Item difficulty was established by using the total population of test scores and comparing the number of correct answers for each item in the test. Item discrimination utilized the highest 30% (*n*=10) of student scores and compared it the lowest scoring 30% of student scores (*n*=10) to determine the correlation of correctly answered questions to overall student mastery levels. This process and these results are discussed fully in Chapter 4.

Young Children's Views of Science

The Young Children's Views of Science is based on nine fundamental nature of science and scientific inquiry areas (Lederman, J. S., Bartels, S. L., Lederman, N. G., & Gnanakkan, D., 2014). Because time constraints were an issue for this study, we greatly abbreviated the original measure, thus nullifying the reliability and validity data. The original protocol can be found in Appendix F, with the revised version in Appendix G. All group interviews were recorded with the exception of groups of students who returned declining parental consent forms. Only participating student answers were transcribed, resulting in *n*=32 with 16 female students and 16 male students in the sample. I quantified the resulting data using a binary coding structure used in the original instrument. A paired sample *t* test was then used for whole group data analysis, followed by an independent sample *t* test to determine if there were differences in answers based on gender.

Sarah organized all second-grade students into groups ranging from 4-7 students. She organized the groups by responses from parent permission slips to participate in the study. Students with parental consent were grouped together, students with denial of consent were grouped together, and students who had not yet returned parental consent forms were grouped together. When possible, Sarah created groups that were equal in female and male participants. Two groups were interviewed at a time, one by myself and one by Sarah, while the rest of the class checked out books. Halfway through the class time, we stopped the interviews and switched groups. In this way, all students present in each class were interviewed during one class time. We recorded all of the interview sessions, with the exception of the groups comprised of students whose parents denied participation in the research. I then transcribed the interviews of students with both parental consent and student assent, which I then coded for the level of student understanding of the concepts. These codes were verified by two external educational experts with a 90% inter-rater reliability. This measure was utilized as both a pre-assessment and post-assessment. The results of the data analysis are presented in Chapter 4.

Ethical Considerations

Personal Background

Prior to this research, I was a K-12 school librarian for 13 years. I practiced for seven years at the elementary school level and six years at the high school level. In addition, I have a bachelor's degree in Biology. These combined experiences were the impetus for investigating the commonalities between the school library and science instruction. I was especially interested in science at the elementary level because while middle schools and high schools usually have teachers that specialize in teaching science, in the elementary school, the teachers are often generalists, thus not specializing in any particular subject, but teaching them all. Because of this, I felt that the elementary school librarian may play an important role in supporting these teachers and may also have an ideal location for allowing students to see the connection between literature and scientific inquiry. However, my background, which was the foundation to my research interest also brought personal bias to the study which may have caused problems with bracketing myself and may also have changed the course of the study.

A Change in Research Design

In the original design of my research, I intended to introduce the science concepts to Sarah, plan the implementation of the pretest and posttest measures, assist with planning the initial lessons, then gradually fade into the background of the planning process. While this original plan did include collaborative planning for the length of the study so that I could gather the materials and give clarification when needed, I intended to shift the weight of my input from heavy in the beginning to minimal in the end. I also intended to obtain (and purchase when required) all necessary materials, set up all inquiry materials before each lesson, administer one pretest, breakdown and clean all materials after the lessons, and put them into storage. Sarah agreed to collaborate to develop lessons and pretests, help gather materials within the school, administer the pretests, teach the lessons, and keep a journal. I would be present during the lessons if Sarah had questions or needed clarification. Except for the implementation of one pretest, and occasionally walking around the room to observe and gather samples of student talk, I did not intend to interact with the students but rather observe from a computer station outside of the main learning space. In short, I did not originally intend to co-teach any of the classes. However, I was only able to conduct this structure of observation for one day (Feb 6th) of the Draw-A-Scientist Test (DAST) pretest. Before the class came in on the second day (Feb 7th), problems with this design began to arise. That morning Sarah was informed that her co-sponsor for SCA would not be able to handle the student candygrams for Valentine's day, which started that morning, and that Sarah would need to put in an announcement, explain to the SCA representatives their duties, as well as collect the money when they returned from visiting the classrooms. Because this was a schoolwide activity, and parents had been notified and sent in money, Sarah was obligated. Second-grade was the first class of the day, directly following announcements, and this SCA obligation ran well into the second-grade instructional block. As a result, I had to decide whether or not to step in and administer the DAST pretest. Because time was an ever-present pressure in this study, and because I was already participating in the administration of another pretest measure, I decided that this would not significantly alter the structure of the research once inquiry lessons began. Candy grams continued for one week, thus also impacting the administration of the second pretest measure, the science inquiry content test.

Again, I chose to step in to keep things in motion as this was only a pretest. However, on the following Monday (Feb 21st), the first day of the planned inquiry lessons, we arrived at school and were informed that the main office had flooded and that the office staff and the school nurse would be relocated to the library. Additionally, because of the confidential nature of student and health records, the library would be entirely closed to all staff and students. During previous instances when Sarah was displaced from the library space, during library closures for testing for example, she generally went into the classrooms with a cart of books for checkout, a laptop, and a barcode scanner. She would read a short story and then spend the remainder of the 45 minutes checking out books on her laptop. This process takes considerably more time in the classroom than it does in the library. This requires her to check in each student's book, review their record, and then let them check out the number of books they are allowed. In the library, this check-in/check-out procedure would have been handled by the library assistant or by a volunteer. Also, due to the structure of the fixed library schedule, many of these students only checked out reading materials once a week, during library instruction. Because of this, we decided early in our planning that book checkout was a priority for the students as this was the only source of independent at-home reading materials for some of them, So skipping book checkout for inquiry instruction was not an option. As a result, Sarah would not be able to teach the inquiry lesson while we were displaced. A snap decision needed to be made whether to postpone the research study for an unknown amount of time, as we did not know how long the office would be in the library, or for me to teach the inquiry lessons in the classrooms while Sarah checked out books. Because there was a limited amount of time to implement the inquiry lessons before the library would once again be closed for standardized testing (which Sarah would also be proctoring) I decided to step in to teach the lessons. I anticipated that we would only be displaced for a day or two, however, we were displaced for over a week.

The classroom inquiry lessons were truncated with less experiential materials due to space constraints, and inquiry book selection was limited by what we anticipated the students would like to research. However, once we were back into the library there was space to spread everything out and students could utilize the entire library collection and utilize the entire library space to visit the various stations to answer questions. However, by this time, I had been solely teaching the inquiry portions of the classes for over a week, and Sarah seemed a bit lost in the process. Perhaps I enabled codependence by stepping in at all, or perhaps this same thing would have happened had we started the inquiry lessons in the library as planned. But as I sat in the back observing during this first inquiry lesson in the library, Sarah appeared overwhelmed with the movement and noise as the students moved around and talked. These were actions I had encouraged in previous lessons, but now resulted in a situation where the students had experience with the lesson procedures, but Sarah lacked that experience. I observed her getting increasingly frustrated as she tried to corral the students, guide them, and quiet them. At this time, I was faced with an ethical dilemma often faced by K-12 teachers who transition into educational research. Larabee (2004) states, “Posed with a situation in which two children are fighting in the back of the classroom, the scholar wants to ponder the social, psychological, economic, and pedagogical reasons for this conflict, while the teacher wants to separate the combatants” (p. 94). As such, I was put in the position of stepping in to assist or continue with my “intellectual fiddling while the classroom burns” (p. 94). I felt that by not giving assistance and stepping in I would be putting both Sarah and the students in an ethically precarious situation of undue stress and anguish at the hands of my research study. Additionally, I am not sure that

Sarah would have continued participation in the study had I sat taking notes while she struggled with previously unknown teaching ideologies, structures, and theories at the expense of discipline and order within her own library setting. As a result, I made the decision to step into the active role of participant and co-teacher, where I assisted in the implementation of the inquiry portion of the lessons and with guiding the students; A role I never fully exited. However, I do not entirely regret this decision. This gave me a greater degree of “insider perspective” which I strived for through my case study design. This affected the way that Sarah and I interacted and planned as well, as I had knowledge of the challenges and successes of students and the classes that I may not have had if I wasn’t working directly with them. Through these interactions, I was able to more fully observe the ways that the students worked through their individual inquiry processes which I may not have observed sitting in the back of the library taking notes. I was also able to gain a more comprehensive insight into the teaching processes and challenges in this specific library as I worked hand-in-hand with Sarah to guide the inquiry portions of the lessons.

This change in research design blurred my lines between researcher and participant. This, combined with my personal background, may have cause other ethical issues which should be considered. Because I enjoyed the process of working with the students I had problems bracketing myself and viewing the research study through an objective lens. As a result of this I may have missed cues indicating Sarah’s stress, and may not have sufficiently applied ethically reflexive practices during this study.

Consent/Assent/Rewards

We issued and parental consent forms to all second-grade students before any of the student portions of the research study began. During our initial planning session, Sarah suggested that we offer an incentive for students to return the consent forms. Faculty and staff in Parks

Elementary School could issue “School Bucks” as an incentive or reward for students. Students could then use these School Bucks to purchase items from a reward cart once each school quarter. Sarah suggested that we use these as an incentive to students and parents to complete and return the consent forms. Because I did not want to penalize students who would not be given permission to participate in the research, the parental consent forms were altered to include a box for consent and a box for denied consent by the parents. In this way, all students that returned the consent forms, regardless of parental consent, could benefit from the incentive. The complete consent form is located in Appendix A. Students that did not return the consent forms after two weeks were provided an additional parental consent form. Three students requested a third consent form as well which were provided to them.

In addition, because the reward cart items were purchased using guidance funds, I was concerned that my issuance of “School Bucks” to so many students would deplete the resources, thus adding strain to the guidance budget. To combat that depletion, I personally purchased $100 worth of supplies to add to the cart over the course of the research study.

I also provided Student Assent forms (Appendix H) to all students, which I read aloud and explained before student data was collected. I only included students that had approved parental consent and also provided personal assent in the student sample. Only one student who had parental consent declined personal assent and was thus removed from the final sample.

I did not use any identifying images of students were in this study. I limited student data sources and images used in this study to the measurements given to the students, and student products produced as a part of the study, with the removal of any identifiable information (such as student name or teacher). I recorded and transcribed all participating student interviews and destroyed the original recordings upon completion of the transcriptions. All data from this research will be destroyed within five years of completion of this study.

We developed all lessons for whole class participation, regardless of consent/assent with no foreseeable risk to students. Science lessons were in compliance with the educational state standards in science for second-grade students. All names in this research study, including students, librarian, teachers, school and school system, were assigned pseudonyms to protect their identity. I maintained all original data sources in a locked office, and on a password protected computer.

I also provided an Informed Consent Document to Sarah. In this form, she agreed to lesson planning and implementation, interviews, surveys, and completion of a personal journal. This document also contains her right to opt out of the study at any time, which I also discussed with her at the time of signing. This is located in Appendix I. It should be noted that, while it was not my intention, there was a considerable amount of additional stress placed on Sarah, which may have resulted in anxiety because of this research, however, she did not choose to opt out of the research study.

Member Verification

I offered the research in part or in whole Sarah for additional verification. I offered to provide these to her to give her the opportunity to address any areas of the research that she felt were inaccurate or were misconceptions. I offered to meet, Skype, or email the entire research study and/or the results to her. She has not responded to the request to verify the information. Because stress on Sarah was evident in the findings, I have decided not to pursue additional communication, thus potentially causing more undue stress.

Roles

Role of Researcher

As the sole researcher, the mentor, and a collaborator in this study, I was an active participant in nearly all aspects of this research. Sarah and I collaborated on the planning of every lesson, we co-taught the lessons together, revised them together, and made future changes together. I worked with the students, actively participated in the pre-testing and post-testing measures, and explained portions of the lessons. I set up all materials before lessons and cleaned up after lesson. While Sarah generally introduced and read all preliminary portions of the lesson, I was present for any clarifications she asked for, and occasionally took lead roles in the lessons when necessary. Students called me by name, asked for assistance, asked for clarification, and showed me their progress. I became well integrated into the culture of the school during the lesson times, talking with other teachers, administrators, and parent volunteers. It was a goal of mine for the entire community to become comfortable with my presence, thus reducing anxiety or guardedness during my research time in the school. Because of this immersion, bracketing was only applied during the coding and analyzation of the data.

Sarah’s Roles

Sarah’s roles in this research were that of teacher, collaborator, and co-creator of the lessons. Sarah was the sole communicator with the classroom teachers concerning information about students and rescheduling lesson times. She maintained the returned parental consent forms and organized students into interview groups. She was my liaison to the office staff and other teachers. She located the library and science materials within the school, and set up the experiential materials for lessons on the two days that I was not available to do so.

Bracketing. Bracketing was difficult with this research since I was so entrenched in the lesson planning, teaching, reflective journaling process, and involvement in general with the school. Because of this I only bracketed myself during data analysis, where I worked to consciously removed my personal beliefs, feelings, and involvement from the coding and analysis of the data. While my involvement may have compromised some of the validity of the research, it provided me with insight into the school and the ways that Sarah worked with her students, the faculty, and the feelings she had. Because of this insider-role, I was able to observe things that I may not have otherwise been privy to. I felt that this rich examination outweighed the validity threat for the purposes of my research.

Trustworthiness/Validity

As previously mentioned, my deep involvement may have threatened the validity of this research. Because I was so involved in the lessons I reflectively journaled but did not reflexively journal during the research study. I may not have been able to fully bracket myself during data analysis. Because I enjoyed the planning and lessons, I may have viewed the results through my own experiences, rather than those of the participants. In addition, because Sarah may not have wanted to offend me, it is possible that she did not readily express negative feelings that may have been concerning, upsetting, or stressing her. Likewise, students may have answered questions and conducted themselves in a manner that is different from regular instruction because of their lack of familiarity with me, or to please me. All of these issues threaten the validity of this study. While little can be done to address the past events and respondent behavior, I made every effort bracket my personal feelings and memories during the reading and coding of transcriptions and journal entries and collaborative sessions. In addition, I addressed threats to coding validity by utilizing outside educational researchers to evaluate and independently code portions of all qualitative data, and to verify the scoring of the Draw-A-Scientist Test (DAST) and the Young Children's Views of Science (YCVS) measurements. All inter-rater reliability was above 80% thus helping to ensure the trustworthiness of the coding and scoring in this research study. Also, in the instance of combining themes of the journals, the outside educational evaluators provided insight into how to more accurately code and combine codes to better represent the data and improve the inter-rater reliability. In this way, even the combination and collapsing of codes from the librarian and researcher journals was verified by outside evaluators.

Limitations/Delimitations

My sample was small. I only looked at one librarian, in one school and her work with one grade level during one semester of one school year. Therefore, this study cannot be generalized to any greater populations. However, a smaller sample like this allowed for more in-depth research, giving voice to the school librarian, insight into student work, and allowed for a more comprehensive view of the successes and shortcomings of the creation and implementation of this information and science inquiry curriculum. I utilized both qualitative and quantitative methods to gain a better overall view of the research, the processes, and of the experiences of the participants. Through these methods, I was provided insight into one possible approach to teaching information and science inquiry with early childhood students which utilized the school library and the school librarian as educational supports in teaching the SSLIM curriculum.

Summary

In this study I utilized a non-experimental mixed-methods case study research design to begin to examine the way one school librarian and an educational researcher created and implemented a unique, learner-centered, science and information inquiry curriculum for second-grade students. I gathered and analyzed qualitative data using transcriptions from collaborative meeting sessions, librarian journals, and researcher journals. Student quantitative data were collected and analyzed through pretest and posttest scores of the DAST, YCVS and science inquiry content test measures. Quantitative data were also gathered for change in librarian science teaching efficacy using the Science Teacher Efficacy Belief Instrument (STEBI-B).

In Chapter 4 will I will present the results from all data sources. I will examine the creation of the SSLIM curriculum through samples of the collaborative meeting transcriptions, exploring the change and the process over time. I will present findings from the analysis of the librarian and researcher journals and results on Sarah's efficacy and feelings about teaching science will be presented. Finally, all analyses of student data sources will be presented through the statistical results of paired sample and independent sample *t* tests, as well as student samples of data when applicable.

CHAPTER 4

FINDINGS

Purpose

The purpose of this mixed-method, case study research was to explore the development of a Science in the School Library Inquiry Model (SSLIM) curriculum which leveraged the synergies between science and library instruction. In this study, I examined the collaborative development and implementation of a curriculum that supported second-grade student science learning in the areas of nature of science (NOS), scientific inquiry (SI), and the diversity of scientists, while simultaneously supporting information literacy through inquiry. I collected qualitative data through nine collaborative planning sessions and librarian and researcher journals. I examined the effects this curriculum development had on the school librarian's efficacy and feelings about teaching science. Additionally, I collected quantitative data through three student measures: The Draw-A-Scientist Test (DAST), the Young Children's Views of Science (YCVS) protocol, and a science inquiry content test, as well as through one librarian measure, the Science Teacher Efficacy Belief Instrument (STEBI-B). The following research questions guided my data collection and analysis.

Research Questions

1) How do an elementary school librarian and an educational researcher, collaboratively plan and implement a learner-centered information and science inquiry curriculum for second-grade students in the school library?
2) How does the development and implementation of this curriculum affect the school librarian's feelings and self-efficacy of teaching science?

3) How do students’ science content knowledge, perceptions about nature of science and scientific inquiry, and ideas about who does science change through information and scientific inquiry lessons in the school library?

I examined these research questions through six primary data sources: librarian and researcher collaborative sessions, librarian and researcher journals, the Science Teacher Efficacy Belief Instrument (STEBI-B), student science inquiry content test, the Draw-A-Scientist Test, and the (modified) Young Children’s Views of Science protocol. The results of each of these measures will be addressed in this chapter and organized by research question.

Sample

The journaling, and the collaboration and curriculum development were conducted with one school librarian (*n* =1) and myself as the participant-researcher, within one elementary school in a Mid-Atlantic state. The student sampling for this study consisted of a small sample (*n* =32) of second-grade students. The student sample consisted of 16 males and 16 females from four, second grade classrooms within the same elementary school. Student samples varied for each measurement, due to student attendance. In order to acquire the largest sampling, student selection for this study included all students who returned both parental consent forms and gave student assent.

Collaboration

Research Question 1

1) How do an elementary school librarian and an educational researcher, collaboratively plan and implement a learner-centered information and science inquiry curriculum for second-grade students in the school library?

Collaborative Sessions

There were nine formal, scheduled, collaborative sessions during which the school librarian (Sarah) and I planned for the student testing and instructional units. I recorded all formal collaborative sessions and later transcribed them. These did not include planning that happened naturally during lessons or in casual conversation, however, I did include instances of these casual discussions in my researcher journal entries. These formal collaborative sessions were conducted at irregular intervals throughout the development of the SSLIM curriculum and totaled 555 minutes and four seconds, or just over nine and a quarter hours. Planning was more frequent in the initial weeks, with a tapering toward the end of the curriculum development. The first six planning sessions were conducted before any lessons were implemented. The following section will examine the analysis of the transcriptions.

Analysis of Collaborative Sessions

The analysis of the data from the collaborative sessions began with recording and transcribing each planning session. Following transcriptions, I deductively applied Kimmel's (2012) phases of collaborative planning as the initial coding structure for analysis. This was done by hand using Dedoose© software. There were several differences between Kimmel's collaborative sessions and the sessions in this research which resulted in a slightly different application of the codes. For example, Kimmel's research examined a standard course of study which utilized state standards with learning outcomes, where our curriculum was not explicitly tied to the state standards and had no pre-established learning outcomes. In addition, Kimmel's collaboration explicitly addressed the sharing of resources amongst the grade level, whereas this research took place solely in the central location of the school library, thus negating the need to schedule the sharing of resources. Finally, I deemed it important to separate out an additional code when we talked about the students (Learners). Because in this research study I explicitly examined the development of the Science in the School Library Inquiry Model (SSLIM) curriculum, which is a learner-centered curriculum, I felt it was necessary to examine how often we talked about the students, as they were indirect collaborators in many of the sessions as we planned the lessons around their interests. As a result, my application of Kimmel's codes was somewhat altered from the original codes. I have provided a comprehensive chart of these applications in Chapter 3, Table 10.

I applied Kimmel's codes to segments of talk surrounding particular topics of discussion, and codes were applied to every word in the transcriptions. This generally encompassed at least one full sentence, but more often, multiple sentences within a discussion were treated as one segment of talk. For example, the following discussion occurred during the second collaborative session and was treated as one segment of talk.

> B: So that would be week two.
> S: And then the six through the ninth would be three, and then… now this - they have guidance there so this is one class, so I'll have to see if maybe she'll let me have her kids, but we can still…
> B: Oh, that's that extra one that loops back around.
> S: It's because the week of the book fair she's taking all of them except for this one because she's having career day that day, so she can't take any. The guidance counselor runs career day, so she couldn't take any of my classes this day.
> B: So what class is that?
> S: [Teacher]
> B: Okay. I'm trying to figure out if there's a way that we can…when we can just do it with [Teacher's class] then and not here.

In this section of discussion we were trying to move classes and get everything scheduled in the weeks to follow, I coded the entirety of the above excerpt for Coordinating. However, occasionally, thoughts would shift mid-sentence. In these instances, I coded the different sections of the sentence as different discussion segments. For example, here is a segment of discussion from our first planning session:

> B: [A focus group is about four people] [and so that’s where we want to see how these come in.]

I coded the first bracketed portion of the sentence for Making Sense because I was explaining to Sarah the format of a focus group, but I coded the second bracket for Learners because I was talking about the student’s returning the permission slips. In this way, I did not limit the unit of analysis by the sentence, but rather by the topic that was being discussed. As a result, there was a great deal of variation in the length of the coded segments or sections. The shortest applied coded segment was five words and the longest was 348 words. Once I applied codes to every word in the transcription, I examined each segment of text to verify the codes individually for consistency throughout the coded segments and to evaluate if other codes were present which may have been overlooked in the first interim of coding.

Two educational researchers verified the coding structure by examining 20% (approximately 22 pages) of the transcriptions to establish the reliability of the coding structure. This resulted in the verification of the coding at an 89% inter-rater reliability. The following sections provide narrative examples of each stage of the processes in the collaborative sessions.

Findings

In the following sections I will share an example of each collaborative process with a discussion of the findings for each.

Coordinating

Coordinating was sections of talk where we discussed the logistics of the lessons. Coordinating included scheduling the classes around other events but was also discussions about setting up and breaking down materials. The following segment from our second meeting contains an example of both:

> S: They have a program in the gym that they have to go to that the PTA has done. So, the other option is that I can see if that teacher will just let me have the class for a little bit, sometime on Friday or…one of these days we could do two classes back to back.
> B: Okay.
> S: Like if she would let me, would that work?
> B: Yeah that would totally work.
> S: Okay.
> B: Because then we could just leave everything out.

In this section, Coordinating included the discussion of moving the class because of the PTA assembly, and then again in my last response when I talk about leaving the materials for the experiential stations out for the next class.

Additionally, Coordinating was talk about coordinating students into groups for the small group interviews or establishing our individual roles during the lessons or testing. The following excerpt shows examples of each:

> B: I think we can probably not only increase the amount of kids in the group but decrease the amount of some of these questions. We're just going to have to be paired out I think. But we can do that together, so…that would be…
> S: So now am I doing this or are you doing this?
> B: Well depending if there's enough kids we may both be doing it.
> S: Okay
> B: So you may do a group and I may do a group and we just may tape record it. But like I said it has to be from kids that have…
> S: That said yes.

Again, in this excerpt there are two examples of Coordinating; the first section where I was talking about organizing the student groups, and again when Sarah questioned our roles in the interview process.

In the initial planning sessions, Coordinating primarily focused on scheduling the classes to determine our overall unit timeline, as well as determining who would be responsible for administering what portions of the pretests. However later in the planning meetings, it became more about managing the materials. As a result, nearly a third of the passages in the first two collaborative sessions were coded for Coordinating as we tried to schedule the class times. But the Coordinating process became less frequent over time and was only about 5% of the planning of the last collaborative session. Additionally, Coordinating was often tied to the fixed schedule of the library. Because Sarah had a fixed schedule of classes that came in at a specific time each week, anytime there was a change in the school schedule, changes in other specialist schedules, or school closing for holidays, this affected the library schedule and required us to coordinate classes to the new schedule.

Passages coded as Coordinating also occasionally overlapped with the Learners code, when the coordination applied to the students. This was more frequent in the beginning of the research study especially when we were trying to coordinate students with parental consent forms into manageable groups for the Young Children's Views of Science (YCVS) pretest measures. Here is an example from a statement Sarah made about the YCVS pretest.

> S: So then after that when we're interviewing…We're only going to interview the ones that said yes. Then the other ones that said no, or anybody, could be looking at the books.

At this time, we were trying to coordinate the pretest interview groups during the larger lessons. Sarah talks about the students who returned parental consent forms being placed into interview groups while the other students check out books. In this way we coordinated the lessons around the students.

The Coordinating process was the portion of planning where we scheduled the lessons, organized materials, grouped students, and determined our individual responsibilities within the lessons. Coordinating was also characterized by solving problems with the library schedule or the library space. This problem solving occurred when there were other school events which required rescheduling of classes, when the library space was being used for other purposes, and when teachers requested to move class times, and were often related to maneuvering within the fixed library schedule. Overall, Coordinating was how we organized our time and materials to create an implement the lessons within the SSLIM curriculum.

Making Sense

In the beginning of the collaborative sessions Making Sense was quite literally, us making sense of what was unknown to each other related to the research and the setting. For Sarah, this was her understanding nature of science, scientific inquiry, the structure of the pretests, and the research study in general. For me, Making Sense was when Sarah explained policies in the school, or other factors specific to the Parks School environment.

> B: What does that mean they have a free day?
> S: So, it’s part of the behavioral system. They have five questions that we ask…it’s a resource thing because we were having a lot of behavior issues in resource and so to try to do something like uniform across all they have… I’ll show you. They come in and at the end of the class we talk about these five things. And then if they earn their tally, then every fourth tally they earn a free day.
> B: So they come in and check out books and they can either do games or if it's nice outside they can go outside whatever?
> S: Yes. It’s just their reward, however, if we’re in the middle of a unit I can say our free day will be such and such.

In this example from the first collaborative meeting, I am making sense of the discipline plan already in place for library classes. Making Sense was more frequent in the first two collaborative sessions as we both worked to make sense of our new situations, but eventually tapered off. By the end of the collaborative sessions, there were fewer instances of making sense of the unknown, and more about us making sense of each other’s ideas. These looked less like an explanation of facts or guidelines and more like explaining books or experiments to the other person, so they could make sense of the idea as it related to the upcoming lessons. The following example of this was from the last collaborative session where we were brainstorming experiments that met the student requests. We were both looking at our computers for interesting experiments that may be applied to our student choice lesson.

> S: Cool milk trick. Oh, this is really cool - I did this with my first-graders one time where you drop the thing and you touch it and it shoots out. Have you seen that?
> B: No I haven't seen that.
> S: So you put… so it's milk and food coloring…so it's actually food coloring and dish soap and milk. You pour the milk and add food coloring and you put the dish soap on the end of the Q-tip and that's what it does. It's really cool.
> B: Wow! We just have to decide if you want milk in here. That's cool.
> S: I know.

In this segment, Sarah was explaining and showing an experiment to me that she had done before so that I could understand what she was talking about. This was characteristic of Making Sense because she was helping me to make sense of the experiment. This section was also coded for Making Connections as we were planning for the lessons coming up.

Passages in which we were Making Sense were also occasionally focused on Learners. This was generally when Sarah was making sense of the pretesting or when I was making sense of policies concerning students. Here is an example of Sarah making sense of the Draw-A-Scientist pretest during our first collaborative meeting.

> S: For this one do I need to do anything? Or do I literally just give them a piece of paper and say draw a scientist?

Here is another example:

> S: Are they picking like one thing and they're going to do a whole inquiry process or are we just exposing them to a bunch of different things?

Here Sarah is making sense of the plan for the student inquiry cycle. In this way, we made sense of the processes and procedures of multiple aspects of the study and the environment, both as they applied to our roles, and also as they applied to what students would be doing in the lessons.

When engaged in Making Sense, we were in the process of learning new things. We were sharing knowledge previously unknown to the other person, and thus teaching each other. In early collaborative sessions, this was characterized by explaining rules or theories, however, by the end of our collaborative sessions, it was characterized by explaining experiences we wanted to share with each other and the students. In this way Making Sense started as a means to establish the ground rules within the boundaries of the study, but later turned into a mechanism for sharing, and as a foundation for Making Connections, which is discussed in a later subsection.

Drifting

During segments of talk when we were Drifting, our discussions veered off topic from the lesson planning. Sometimes this had to do with feeling tired or sick, or sometimes it was personal stories. Often it had to do with getting lunch.

> B: What time is your lunch?
> S: Technically it's right now.
> B: Do you want to get something to eat?
> S: Okay.

The process of Drifting only reached more than 10% of a collaborative meeting in the eighth meeting. In that particular meeting, Drifting reached almost 20% of the passages. This may be because we were planning around the upcoming book fair and spring break, and veered off to talk about our personal plans. However, it may have significantly increased because we both expressed that we were feeling burned out during this meeting and, as a result, drifted off topic more often. We were also coming to the end of the lessons that needed planning, so there was less pressure to get the lessons completed than there was in the initial phases of planning. Here is an example of how our discussion about materials drifted off from concrete planning:

> B: Do you think I should put the lemon juice in the fridge?
> S: Does it say needs to be refrigerated?
> B: I'm not sure. Refrigerate after opening. Yeah.
> S: Yeah maybe.
> B: It'll probably get kind of nasty.
> S: I can put it in the back…like so other people don't think that they can use it.

In this segment, we were talking about a bottle of lemon juice being used in student experiments. Sarah was offering to store it in the teacher workroom refrigerator since up to this point we had been storing all materials in the library. This portion of the conversation had little to do with planning, so it was coded for Drifting. Passages coded as Drifting were, by definition, not about planning and therefore never overlapped with other processes such as Making Sense or Orienting.

During segments of talk when we were Drifting, we shared personal information, made jokes, talked about other obligations, shared stories about our families, complained, and commiserated. In this way, Drifting was a way to become more comfortable with each other and to build trust. Drifting also occurred when the planning session were long, or we had extensively talked about a topic. In this way Drifting was also a kind of "brain break," and a way to mentally reset from cognitive overload. In collaboratively creating this curriculum, Drifting was a necessary component in building our relationship and trust as well as allowing us some space within the structure of planning to relax and casually talk.

Orienting

Orienting was the process of aligning our thoughts during the meetings. This code frequently was the first code of the meeting session.

> B: So what we want to start with? Do we want to start with grouping the "no" students or do you want to start with the Young Children's?
> S: Maybe do that first. I think that would be easy. And do we want to look back over the pretest?
> B: Yeah, we're going to want to go back and revisit that.
> S: We wanted to look at the magnet question again.
> B: And we only have nine too. We are putting one more question in there I think.

Orienting also occurred when we were getting back on track, generally either after drifting or an interruption. These tended to be short statements followed by another process such as Coordinating. The following segment happened after we were interrupted by a teacher:

> B: Okay so for next week I'm trying to think of the logistics of this.
> S: Of getting it all set up?

This was us getting back on track after being distracted by the conversation with the teacher. In this section I was restating where we were in the meeting, so we could progress with the planning. Orienting was also applied to segments of talk where we were reviewing topics we had previously discussed to remind each other of the previously stated plan.

> S: Last time we talked we said that this week, April 10, we would do our last lessons, and then we don't have second grade the following week, and then they would either be grouped or assigned to a group, and each group would share. And then they would Draw-A-Scientist and content posttest.
> B: Okay yeah. That's what I thought but I couldn't quite remember.

In this section of talk, Sarah was reminding me what we had previously planned for the upcoming schedule of lessons because I had forgotten. Orienting was the lowest occurring of any of the types of talk within our collaborative sessions, and only once exceeded 3% of the application of codes. This was in the fifth meeting. During this meeting we were finalizing the pretest measures and were moving between them. Because of this regular shift of topic, there were longer segments of Orienting where we reviewed and brought each other up to speed on our progress from previous meetings.

The Orienting process generally started meetings and followed interruptions and Drifting. It was the way we got back on topic and/or reviewed previously discussed topics. Orienting was characterized by a motivation to get back to the process of planning or to get back to the topic at hand. During these times of Orienting, we allowed ourselves the necessary time to review and realign to new topics of discussion. Orienting was a critical component in creating the SSLIM curriculum, in that we shared notes, reminded each other of previous conversations, and refocused ourselves.

Making Connections

Making Connections happened during collaboration when we connected what we wanted to do with students to resources, standards, and/or objectives. These connections looked like the "meat" of the planning and were the segments of discussion when creative ideas were presented and problem-solving seemed to happen. Making Connections occurred fewer times in the initial planning sessions when Sarah and I spent the majority of our planning time Making Sense, but as the collaborative session progressed through the duration of the research study, Making Sense decreased in frequency and Making Connections increased. In the following excerpt, we were trying to meet multiple objectives by identifying scientists to teach about during the lessons while also utilizing state standards to try to meet state testing objectives.

> S: In second grade there's no scientists in there. It's got George Washington, Abraham Lincoln, Anthony, Keller, Martin Luther King but there's no scientists. Okay, let's go to science one. I know that we have a book in our library called "Now and Then" which gives a lot of the different things that Benjamin Franklin invented. It doesn't necessarily talk about how he invented them which is part of our focus, right?
> B: Yeah, umm…
> S: But if we were doing something with Benjamin Franklin and we were talking about the types of inventions that he did, could their stations just have a bunch of different materials like where they could try to invent something? Like recyclables and stuff like that? Where they could… I don't know I'm just throwing things out there.

In this section of talk, we were still trying to position ourselves and the lessons within the research study objectives. Additionally, we were trying to connect resources that would allow for both introduction through literature and also materials for the experiential stations. But as we became more familiar with each other, the study objectives, and the policies and procedures, we were able to spend more time making these connections across learning objectives and to resources. Making Connections was over 50% of the talk during five of the nine collaborative meetings, and as we progressed in our planning sessions, was more often coded with Learners as well. This segment is from our sixth planning session. At this time, we had administered the DAST and were finalizing the science inquiry content test.

> S: Do you think that a question to ask them would just be something about where science takes place?
> B: Yeah, I think that's a great question.
> S: Based on the drawings that I saw, and I didn't see all of them, but most of them are drawing a lab, you know? I didn't see many of the scientists, like, out in the world.
> B: From our books?
> S: No, I mean from the ones that they drew.
> B: Oh, right.
> S: Like they… most of them are associating a lab with scientists.

In this segment, we were both Making Connections and also talking about Learners. Sarah was discussing possible questions to be added to the science inquiry content test, based on student drawings from the DAST pretest but was also referring to the lesson, and relating it to our objectives of teaching diversity of scientists and the sciences. As the planning progressed, and we built the lessons around what the students liked, Making Connections and Learners were more often talked about together. By the last collaborative session, nearly all of the talk about Learners was embedded into Making Connections. This is discussed more fully in the following subsection.

The most significant portions of the collaborative session were Making Connections. During these times we were connecting to content and objectives of the curriculum. We were building on each other's knowledge to pull together these objectives into a cohesive curriculum. Making Connections was also characterized by excitement, risk-taking, and statements that began with "what if we…" or "could we…". In this way we were also building trust and making connections with each other. We were putting ideas out there for discussion, and possibly rejection. Making connections was also characterized by "ah ha" moments when we cohesively formed connections to objectives and resources. Making Connections was the portion of the collaborative process and curriculum creation where the actual creation of the lesson plans took place. It was the process we utilized when we developed the plan for each lesson, determined the materials that would be used, anticipated student choice, and tied it all back to the back to the main objectives of that lesson(s) and the overall inquiry curriculum. An overview of lessons and materials can be found on p. 115 in the following main section, Thematic Discussion, Table 14.

Learners

We built the SSLIM curriculum around the learner-centered ideology, and so I wanted to specifically look at the way we talked about students in the planning sessions. The ways Learners were talked about varied. Sometimes the talk was specifically about the students during the lessons.

> B: I've been going through their journals and most of them have observations but nothing from the books.
> S: Even from the first day? I thought the first day people did.
> B: The first day people did the most I think. But a lot of them, especially today's class, it's all observation.

However, there were also many passages where the talk about Learners also involved Coordinating, Making Sense, and/or Making Connections. Ultimately, it was a goal for the talk about Learners to also be about Making Connections as we built the lessons around the students' interests and choices. In the following segment, we were talking about the experiential portion of the final inquiry lesson. At the end of the previous lesson, we had asked students what they would like to learn about in the last inquiry lesson, and we recorded their choices. In this segment we are referring to the student choice list, trying to figure out ways to meet as many of the student requests as we could.

> S: I mean I think… I guess we could do like two recycle tables. Basically, one where they are creating things that can help animals and one where they're just creating things that

> can help… I mean they could just be creative, and it could be something that can help them at home or at school or whatever.
> B: Okay.
> S: But then it is just the same thing that we already did. But maybe not everybody got a chance to go there and that's why so many people said it. Because we only did that for one week.
> B: Right. That was not a carryover station.
> S: Right.
> B: A lot of the kids that told me they had done it…I think they just really enjoyed it. But, I mean, we could do recycling to help the earth, including animals, recycling or up-cycling, whatever.

Many of the students had requested learning more about animals, however bringing animals in for an experiential station was not possible in this research study. Also, many students had requested repeating an experiential station from the previous week where they upcycled materials into new "inventions." In this section of talk we discussed how to combine these two ideas into one station but based entirely on student choice. Here is another example of the learner-centered planning.

> B: Okay. Chemistry…
> S: We've got one… Six total… Seven.
> B: Okay.
> S: Animals we've got one, two… we've got bugs, so maybe three, four…six? So, littering we've got four, five…seven.
> B: Okay so it looks like obviously volcanoes can go.
> S: Well can we make volcanoes part of chemistry?
> B Yeah, we could we could if we wanted to do that.
> S: Because that's a reaction, right?
> B: Yes.

In this segment of talk, we were counting votes on topics the students verbalized that they wanted to learn about. Again, we were also attempting to get as many student choices into the lesson as possible. This can be seen where Sarah suggests we combine the votes for volcanoes with the votes for chemistry, by doing a station with baking soda and vinegar volcanoes. In this way we were planning for the students and their individual inquiry interests.

Learners was talk about the students but also a main component to the planning since this was a learner-centered curriculum. While they were not directly present in the collaborative planning session, we brought student opinions and preferences into the planning sessions. In this way the students had a “voice” in the planning of the lessons. In creating a learner-centered curriculum, observing student choice and asking for their opinions was critical to the development of the curriculum.

Thematic Discussion

Collaboration on the creation of a novel curriculum shows many similarities to collaborative planning on an established course of study, however, there are significant differences that occurred. Kimmel (2012) discussed how the majority of talk about students eventually folded into Making Sense and was counted as such. ““Making sense” about students frequently involved informal teacher assessments about students and how they understood concepts” (Kimmel, 2012, p.11). However, in this research, I separated passages about Learners out into their own distinct category. While in the beginning talk about students occasionally involved Coordinating and sometimes involved Making Sense, by the end of the research, when we were familiar with the objectives and the setting, talk about Learners became nearly synonymous with Making Connections, as we explicitly built the lessons entirely connected to their interest-driven topics. As a result, the final collaborative session reflected the desired outcome of the learner-centered and driven, inquiry-based planning, with the highest amount of talk about Learners also involving Making Connections.

As we developed and implemented this novel curriculum, significant time was needed for Sarah and I to make sense of the environment and the study. Instances of Making Sense did not significantly drop until after the fifth planning session. In examining the first five sessions, we spent nearly 30% of each session engaged with Making Sense. The entire time spent in these initial five planning sessions totaled nearly 400 minutes (6.67 hours) of planning. Of this time, nearly two hours (116 minutes) of planning were dedicated, entirely, to making sense of the environment, what we were doing, and how we were going to do it.

As Making Sense decreased, Making Connections increased. As we spent less time making sense of the unknown, more time could be dedicated to making connections to resources, activities, standards, etc. While the instances of Making Connections peaked at approximately 65% of the talk in the 6th and 7th planning sessions and then seemed to slightly decline in the eighth and ninth planning sessions, it should be noted that simultaneously the talk about Learners increased accordingly in the eighth and ninth planning sessions. This was a result of the overlapping codes between Learners and Making Connections and was due to explicitly planning to the learner-centered ideology and environment.

The SSLIM curriculum creation and development, was time consuming and the process was sometimes messy. In the initial meetings, much of the time necessitated dedication to Making Sense of our surroundings and of the research study. However, once we had established the objectives, expectations, and guidelines more time could be dedicated to Making Connections. During these instances of Making Connections, the creation process took place and the curriculum was formed. Through Making Connections and Drifting, trust-building occurred which was necessary for proposing new ideas and thoughts. Once the lessons began with students, it became easier to plan to the Learner, as we could observe and talk to the students about their preferences of the experiential stations. As a result, all of the phases of collaboration worked together, with some increasing and others decreasing as the collaborative sessions progressed. It was a process of sharing and creating and regularly circling back around to the learner while still meeting science and library objectives and within a fixed schedule. The following table (Table 14) provides an overview of the lessons we developed, including the literature and the materials for each student-driven inquiry cycle.

Table 14

Overview of Lesson Plans

	Dates	Books/Online Resources Used	Lesson Activities	Materials
1	2/6-2/9	Selection of books on diverse scientist. (Appendix J)	DAST pretest Identify differences of scientists	Blank sheets of paper for DAST Student Journals* (in all lessons) Pencils Crayons
	2/13-2/17		NO SECOND GRADE (Guidance)	
2	2/21-2/23	What is a Scientist? by Barbara Lehn	Science inquiry content pretest, YCVS pretest	Science inquiry content pretests Pretest PowerPoint Abbreviated YCVS Recorders
3	2-27-3/2	What is a Scientist? by Barbara Lehn A Picture Book of George Washington Carver by David Adler Selection of plant books (Sample of books selected located in Appendix J)	Botany (lesson 1) **Review:** What is a Scientist? **Discussion:** George Washington Carver Botany as a science **Investigation centers:** 1) Closely examine plant parts 2) Dissect a seed/sprout/plant 3) Seed experiments for next week 4) Measure and compare sprouts to seeds	**Materials by center:** 1) 5 Microscopes, magnifying glasses, pansies, work trays 2) beans, bean sprouts, pansies, 3) Bottles with soda, lemon juice, or salt water; paper towels, Ziploc bags, dried beans 4) Dried beans, bean sprouts, scales, rulers, magnifying glasses
4	3/6-3/9	Selection of plant books	Botany (lesson 2) **Review:** GWC Botany	**Materials by center:** 1) 12 Microscopes, 5 prepared plant slides (onion skin, Zea stem, buttercup stem, lily

			Investigation centers: 1) Examine plant parts under a microscope 2) Dissect a seed/sprout/plant 3) Examine last week's seeds 4) Measure and compare sprouts to seeds	anthers with pollen, lily ovary), magnifying glasses, pansies 2) Beans, bean sprouts, pansies 3) Bags with bean experiments from previous week 4) Dried beans, bean sprouts, scales
5	3/13-3/16	Ocean Sunlight: How Tiny Plants Feed the Seas by Molly Bang Rachel Carson: Clearing the Way for Environmental Protection by Mike Venzia Selection of water, environmental and recycling books	<u>Marine Biology / Ecology (lesson 1)</u> **Discussion:** Rachel Carson Marine Biology Ecology **Investigation Centers:** 1) Cleaning oil spills from water 2) Cleaning oil spills from coastal life 3) What's in a drop of water? 4) Measuring chemical changes in water	**Materials by center:** 1) Graduated cylinders, glasses with 50 mL water and 5 mL oil, sponges, peat moss, cloth towels, paper towels, cotton balls, latex-free gloves, Dawn dish soap 2) One glass with water and oil (no specific measurement), feathers, reeds, marsh grasses, sticks, small rocks, seashells 3) 6 microscopes, water sample from local brackish water source, slides, pipettes 4) 3 glasses of water, bottle of lemon juice, bottle of vinegar, bottle of baking soda and water mixture, litmus paper strips
6	3/20-3/23	Selection of water, environmental and recycling books	<u>Marine Biology / Ecology (lesson 2)</u> **Review:** Rachel Carson Marine biology Ecology **Investigation Centers:** 1) Cleaning oil spills from water	**Materials by center:** 1) Graduated cylinders, glasses with 50 mL water and 5 mL oil, sponges, peat moss, cloth towels, paper towels, cotton balls, latex-free gloves, Dawn dish soap 2) One glass with water and oil (no specific measurement), feathers, reeds, marsh grasses,

			2) Cleaning oil spills from coastal life 3) Upcycling inventions 4) Measuring chemical changes in water Ask students their choice for next lesson	sticks, small rocks, seashells 3) Recycled materials such as cereal boxes, plastic bottles, paper towel rolls, etc.; crafting materials such as ribbon, yarn, glue, tape 4) 3 glasses of water, bottle of lemon juice, bottle of vinegar, baking soda, litmus paper strips
	3/27-3/30		BOOK FAIR – No classes	
	4/3-4/6		SPRING BREAK	
7	4/10-4/13	Selection of books on recycling, garbage, and states of matter. Websites: http://www.instructables.com/id/Oobleck/ http://www.wikihow.com/Make-Oobleck http://www.sciencekids.co.nz/experiments/vinegarvolcano.html http://www.makeandtakes.com/bottle-bird-feeder	Student Choice Inquiry **Review:** Student Choices **Investigation Centers:** 1) Circuits 2) Oobleck / Baking soda and vinegar 3) Upcycled inventions 4) Upcycled birdfeeders	**Materials by center:** 1) 8 D batteries, paperclips, aluminum foil, ribbon, yarn, miniature light bulbs 2) Corn starch, water, glasses, spoons, baking soda, vinegar, small plastic bags, pipettes 3) Recycled materials such as cereal boxes, plastic bottles, paper towel rolls, etc.; crafting materials such as ribbon, yarn, glue, tape 4) Plastic water bottles, plastic spoons, birdseed, glue, ribbon/yarn/string
	4/17-4/20		NO SECOND GRADE (Guidance)	
8	4/24-4/27	S is for Scientists: A Discovery Alphabet Book By Larry Verstraete	Presentations in the library. Students present their research. Stress the importance of collaboration in science.	Student journals Students grouped by student-chosen topic
9	5/1-5/4		DAST and science inquiry content post-test	Blank sheets of paper for DAST Pencils

				Crayons Science inquiry content post-tests Pretest PowerPoint
10	5/8-5/11		Finish post testing in the classroom during SOLs	Abbreviated YCVS Recorders

Within each inquiry lesson the students created their own unique question, investigated it in a book or other non-fiction resource, and then chose an experiential station to further investigate or problem solve their question. Some lessons, like lesson four, were a continuation of the previous week's lesson. In these lessons, we began the lessons with a brief review of the scientist and science concepts in that lesson, an overview of the experiential stations of that week, and then allowed the students to proceed to the inquiry process. We designed these lessons to allow time for students to conduct multiple cycles of inquiry if they chose to do so. However, if a student needed or wanted more time to conduct the textual or experiential inquiry, they had the freedom to make that choice. As a result, some students completed three cycles of inquiry within a given class time, where others did not fully complete one cycle in that same timespan. In this way we created the lessons so students could participate at their own pace, within their own levels of learning, and driven by their own motivations.

While this research question and analysis gives insight into the processes of collaborative curriculum creation, there may be further reaching ramifications of creating such a curriculum. The next research question examines the implications that the creations of this curriculum had on the librarian's self-perceived efficacy in science and her feelings about the planning and implementation of the lessons.

Librarian Feelings and Efficacy

Research Question 2

How does the creation and implementation of this curriculum affect the school librarian's feelings and self-efficacy of teaching science?

Librarian and Researcher Journals

The primary data for this research question comes from the librarian's journals. Sarah journaled from February 6th until April 19th. She generally recorded her journals during the evenings following inquiry lessons, but occasionally she combined journals into a week synopsis. This depended on her schedule, other obligations, or her feelings of being overwhelmed. This resulted in a total of 27 journal entries. I also kept a researcher journal that provided data of my own observations within the school, issues surrounding the research study, and feelings I had about the lessons. My journal entries also served as a source of data and as means of comparison when developing the coding structure. However, for the purpose of answering this research question, the examples provided are primarily those of Sarah's, with my own entries serving as a means of comparison.

Feelings

Feelings were the portions of journal entries where Sarah expressed either positive or negative feelings about the lessons or the planning sessions. Feelings can be further broken up into Positive Feelings and Feeling Overwhelmed. Examples of each follows.

Positive Feelings. Positive Feelings were characterized by relief, hopefulness, encouragement from outside sources, clarity in understanding, and feelings of success.

> S: I feel better having a general overview of what we are going to focus on.

> S: Again, today the students were really excited about what we were doing, and the teacher made a comment about how "cool" it was…We even had a fourth-grade student

> in with us today helping and he really enjoyed getting to help the younger students and commented to me that they were doing a great job.

Feeling Overwhelmed. Feeling Overwhelmed encompassed feeling tired, stressed out, or frustrated, but was also characterized by feeling unsure, nervous, confused, or under pressure.

> S: I'm still not clear exactly what we are going to do for our unit/lessons and that is a little stressful but hopefully it all comes together.

Additionally, Feeling Overwhelmed could be expressed as emotional or physical feelings. The following examples from both of our journal entries, reflecting on the same planning session, show Sarah's feelings of being overwhelmed as confusion, where my feelings of being overwhelmed are portrayed as physical and/or mental exhaustion.

> S: I'm confused about how the students are going to create the questions, make observations, look up information, and then revise/rewrite their questions. Hopefully we are not planning more than what can be accomplished in the time frame we have.
>
> B: This was a LONG and tiring planning session. While Sarah is a perfect person to work with, developing a lesson or lessons like this is exhausting. We were really pushing through the plan.

Planning and Implementing Lessons

Planning and Implementing Lessons were generally passages of journal entries where we recounted events from the lesson that day. However, these also encompassed future lesson plans. These entries were largely procedural in nature. The following are examples from Sarah's journals.

> S: Today we started with the 2nd round of pretests. We are giving out student assent forms. The students are taking the content pretest and the YCVS.
>
> S: Today we began our 2nd set of lessons. These lessons focus around marine biology, ecology, and Scientist Rachel Carson. I read two books, one about the ocean and the other about Rachel Carson's life.

Problems with Time

Problems with Time encompassed Other Obligations, Scheduling, and Time Constraints. Problems with Time were characterized by a struggle to fit everything into the lesson, study, or work day. Examples of these different problems with time follow.

Other Obligations. Other Obligations were passages where we journaled about overlapping portions of our life and work. Sometimes these were personal in nature.

> S: My daughter stayed home sick today so my husband stayed with her – she ended up having strep so I will have to be out with her tomorrow.

More often these had to do with additional responsibilities within the school that Sarah was responsible for. In the following examples I provide Sarah's account of a last minute SCA responsibility, followed by my account of the same instance.

> S: In the few minutes between my morning duty and my first class coming, I now had to make an announcement that SCA reps needed to come to the library, explain to the SCA reps what they needed to do, and then show them where to put the baskets when they were done.
>
> B: As she checked messages in email she left in a hurry to make an SCA announcement for the representatives to come to the library.

Scheduling. Scheduling were passages specific to the necessity to move class times around other events in the school, holidays, or teacher requests.

> S: We have two classes today because of something that is going on next week.
>
> S: Today we saw [Teacher's] class. We normally have them on Thursday, but our Art teacher needed to be out of the building and since I didn't have a second-grade class today, I was able to take her second-grade class.

Time Constraints. Time Constraints were passages where we journaled about struggles to fit everything into the library class time, or into the research study in general. Here are examples from both of our journals from the same day where we talk about the time constrains of implementing the YCVS.

> S: In the short amount of time we had, it was hard to get through our shortened version of YCVS.
>
> B: So we did our interviews but only got thorough about 4-5 questions before we had to switch groups.

Supports Needed

Supports Needed encompassed Displacement and Lacking Resources. These were passages primarily characterized by needing something additional (materials, location, or people) that was not present in the school or the lesson. It is also characterized by the necessity of these supports to successfully implement a curriculum such as this.

Displacement. Displacements were passages about the library being closed to students, teachers, and Sarah. While a few passages were about testing or meetings, these expressions were journaled much more often during the time we were displaced due to the flooding in the office. Here are examples from the same day of journal entries from both journals.

> S: Today we got into school and found out the office had flooded and the office staff and the nurse would be taking over the library so we would have to be on a cart.
>
> B: So we loaded the microscopes, the pre-pulled books, the seed sprouts, rulers, magnifying glasses, different solutions (water, salt water, sugar water, soda, and lemon juice all in labeled water bottles), balance, paper towels, and science journals on to a cart and took it along with a book cart for student selection and checkout to the classroom.

Lacking Resources. Lacking resources primarily addressed materials and people which were needed within the school, library space, or lessons, but were not present. The following passages are from the same journaling day and address the need of both inquiry resources and also resources provided by the library assistant and the library volunteers.

> S: Unfortunately, we couldn’t have students make observations at the electricity table because we couldn’t find the bulbs.
>
> B: I also misplaced the light bulbs, so that station will have to wait for next week when I’ll let each child do it.
>
> S: Also, the volunteer that normally comes in to check books in and out because my assistant is at her other school on [day of the week] did not show up today.

Talk about Students

Because this was a learner-centered curriculum, I wanted to see how we talked about students within our journal entries. Some of these passages are about permission slips, or grouping students for testing.

> S: None of her students have turned in their permission slips so today we just did the draw a scientist pretest, introduced Mrs. Ruzzi, set up their science journals, the students completed their first journal activity, and they checked out.

However, more often Talk about Students is characterized by stories about what was or was not going well within the lessons. Sometimes our observations differed on how students were doing. The following passages show differing perceptions about how the students moved through the inquiry cycle within the same lesson.

> S: They are still wanting to spend all of their time at the observation stations but they are not wanting to spend time researching in the books and writing their findings in their journal.
>
> B: and though they needed help finding the book/online information they did a good job of answering at least 1 question through text and inquiry. Most of the students seemed to enjoy the lesson.

Some of these entries about students also contained feelings about the lessons or the process. The following entry from Sarah’s journal displays an example.

> S: The students really were engaged with the activities today. One of the students who doesn’t write much in his journal was completely enthralled with the electricity table. He really got into showing the other students how to make it work, he even asked if he could show his brother who is in fifth grade. To encourage him to have a good day, I told him that if he had a good day I would let him and his brother come down at the end of the day and he could show him. He did have a great day so I took the stuff to his classroom and his brother came down and he showed his brother. His brother asked, “How is he doing that?” I asked the 2nd grader to explain it to his brother and he was able to tell him. I was super impressed!

As can be seen in this entry, Sarah expresses her feelings of being impressed about the knowledge of one of her students after the inquiry lessons. Some sections of this journal entry also overlapped with Positive Feelings.

Feeling Overwhelmed

Throughout her journal entries, Sarah regularly journaled about feeling overwhelmed as feeling tired, unsure, frustrated, or short on patience. Sarah's passages about being overwhelmed outnumbered any other coded passages in her journal. And while I also journaled about similar feelings, Sarah journaled about them nearly twice as often.

This is significant, for two reasons. First, this research question expressly addresses her feelings about teaching the science lessons. The fact that Feeling Overwhelmed dominated her journal entries indicates that she may not have enjoyed or felt comfortable with the research in general. It is also significant in that while she expressed some uncertainty and trepidation in the collaborative sessions, it was not until I viewed her journals that I understood the extent to this was affecting her on a daily basis. Additionally, the stress of the time of the research study as well as the time constrains of fitting all of the activities into the class periods interacted significantly, as there were several instances in her journals where Time Constraints was directly related, often within the same sentence, to Feeling Overwhelmed.

Time Constraints and Feeling Overwhelmed

Time, or lack thereof, was a constant challenge during this research study. As was evident from Sarah's journals, this challenge of fitting everything into the lessons within the time frame of the research, as well as the within the scheduled class times, turned into stress for Sarah. In the following excerpts, it can be seen how Time Constraints affected her Feeling

Overwhelmed. These codes have been separated by brackets to more clearly denote the application of the interacting codes.

> [Since we have so much to try to fit in and such a limited time to get it done], [I felt like I was getting frustrated when the students were getting chatty or not listening.]
>
> [Unfortunately, because we are short on time I spoke to them but let it go because we have to keep moving.] [I don't like how stressed for time we are.]
>
> [As I read and the time was ticking away], [I would feel pressured to get through the books so the students could get to their investigations]

As can be seen from these entries, time and stress interacted significantly. The pressures of the lessons and the amount of time we had to get them in weighed heavily on Sarah's feeling about the lessons and the research in general. It is possible that Sarah felt the research study took priority over her discipline plan, which may have caused her additional frustration. Although it was not explicitly stated, this time pressure may also have been tied to the fixed library schedule, as on most days, Sarah had kindergarten classes scheduled directly after the second-grade class. Because of this schedule there was no time for lessons to run over, as the second-grade teachers were expecting her to return their students, and the kindergarten teachers were waiting for her to pick up their students.

Because this research question seeks to answer the question of "How does the creation and implementation of this curriculum affect the school librarian's feelings and self-efficacy of teaching science?" Sarah's expressions of her feelings separated into Feeling Overwhelmed and Positive Feelings, were isolated and analyzed chronologically over the duration of her journals to determine if her expressions of feelings changed over the length of the study. The following line graph (Figure 3) examines the expressions of these two categories of feelings over the course of Sarah's journaling.

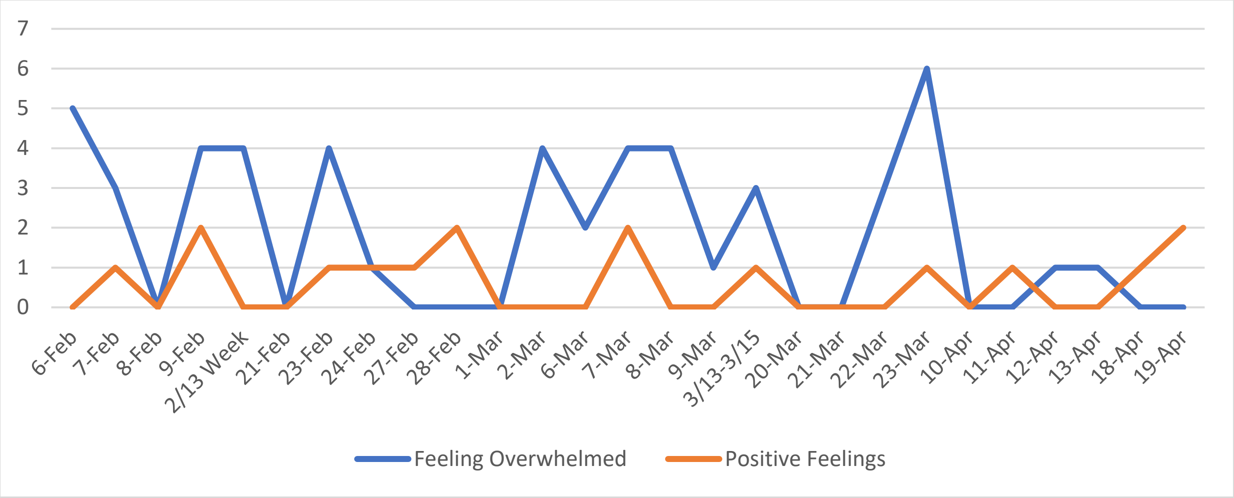

Figure 3. Sarah's journaled feelings over time

As can be seen, her expressions of Feeling Overwhelmed and Positive Feelings varied throughout her journal entries. While one aspiration of the research was to increase her feelings of efficacy and positive feelings about teaching science, her journal entries do not indicate an increase in positive expressions of feelings from day to day, and passages where she expressed Feeling Overwhelmed peaked toward the end of her journal entries. Because her journal entries were only one of two data sources used to examine her perceptions about the research and teaching science, the following section will examine any self-reported changes in her efficacy beliefs through the Science Teacher Efficacy Belief Instrument (STEBI-B).

Science Teacher Efficacy Belief Instrument (STEBI-B)

Another data source I utilized in an effort to answer this research question came from the Science Teacher Efficacy Belief Instrument (STEBI-B). I gave this instrument to Sarah as a pretest and posttest measure in an effort to establish any changes in her science teaching efficacy over the course of the research study. The STEBI-B is a Likert-type survey consisting of 25 questions, developed for practicing general education teachers, about the self-perceived ability to effectively teach science and the expected outcomes this teaching may have on student learning.

These questions are categorized as *self-efficacy* and *outcome expectancy*. According to Riggs and Enochs (1990) “Behavior is enacted when people not only expect certain behaviors to produce desirable outcomes (outcome expectancy), but they also believe in their own ability to perform the behaviors (self-efficacy)” (p.4). Because the survey questions are both positively and negatively phrased, I applied both regular and reverse scaling to the scoring of the answers to establish change in positive and negative responses. I then conducted a paired sample *t* test (Tables 15 and 16) to examine any overall changes in Sarah’s efficacy of teaching science.

Table 15

STEBI-B Descriptives

	n	*M*	*SD*	*SEM*
Pretest	25	3.08	0.91	0.182
Posttest	25	3.12	1.01	0.203

Table 16

STEBI-B Paired Sample t test

				95% CI				Sig.
	M	*SD*	*SE*	*LL*	*UL*	t	Df	(2-tail)
Pre-Post	-0.04	0.89	0.178	-0.41	0.33	-0.23	24	0.824

The STEBI-B scores for the pretest measure (*M* = 3.08, *SE* = 0.182) when compared to the STEBI-B posttest measure (*M* = 3.12, *SE* = 0.203), do not show a significant change in scores *t*(24) = -0.23, *p* = 0.824. To further examine if there were any significant changes in her self-efficacy or outcome expectancy when measured independently, I grouped these questions by outcome or efficacy, and conducted an independent sample *t* test using the change in scores. The results are presented in Tables 17 and 18.

Table 17

STEBI-B Group Statistics

	Efficacy_Outcome	*n*	*M*	*SD*	*SEM*
Change	Outcome	12	0.0833	0.9962	0.28758
	Efficacy	13	0	0.8165	0.22646

Table 18

STEBI-B Independent Sample t test by Efficacy and Outcome

		Levene's Test		*t* test for Equality of Means						
		F	Sig.	t	df	Sig. (2 tail)	*M* Diff.	*SE* Diff.	95% CI	
									Lower	Upper
Change	*Eq. var. assumed*	1.435	0.243	0.23	23	0.82	0.08	0.36	-0.67	0.83
	Eq. var. not assumed			0.228	21.35	0.822	0.08	0.36	-0.68	0.84

Again, when pretest and posttest scores of Outcome (*M* = 0.08, *SE* = 0.288) and Efficacy (*M* = 0.00, *SE* = 0.817) were compared, there was no statistical significance in her change of mean scores *t*(23) = 0.230, *p* = 0.243. This indicates that she did not show any significant change, either positively or negatively, in her beliefs about teaching science at the time of posttest. In fact, while there was a very slight change in the mean scores of her outcome expectancy, there was no change in the mean scores of her self-efficacy at all.

Compared Results of Perceptions about Teaching Science

As the STEBI-B results indicate, there was little change in Sarah's self-reported efficacy beliefs or outcome expectancies from the pretest measure to the posttest measure. Sarah's journal entries indicated that her positive expressions of feelings about teaching science also remained low throughout the research study, and that she may have felt more overwhelmed as the study progressed. While one of my objectives in this research study was to introduce science to Sarah as something that was "doable" in the library and increase her perceptions about her ability to effectively teach science, neither the results of the STEBI-B nor the results of the journal entries indicate that this change in science teaching belief or feelings about teaching science occurred.

The results from this research indicate that over the four months of this research study, Sarah's perceptions about her ability to teach science did not significantly change, and her feelings about teaching science may have decreased. This may be due to the large amount of information and the high demands that I imposed on her through this research study. The development of a curriculum of this size and within the time constraints of the study, caused a significant amount of stress to Sarah. SSLIM curriculum planning impeded on her scheduled time for planning her other classes. In addition, the amount of set-up and breakdown, as well as the mess created by the lessons and the storage of materials eventually began to weigh on her as well. While I believed the lessons generally went smoothly, Sarah worried about the long-term effects on the student behavior in the library. Sarah's journals were an invaluable source of insight into the daily struggles she was feeling throughout the curriculum development and implementation of the lessons.

In contrast, there were entries in my own journals of instances when Sarah seemed to embrace the process and the science lessons. While these scenarios were not present her journals, I believe they warrant mention.

> B: Sarah told me today that she had a very well behaved fourth grade class yesterday. She took the opportunity to draw some pond water samples for them to examine as a reward. She said they really enjoyed it. I think this is a real accomplishment, as she had to set up everything and draw the samples on the slides herself. More importantly she saw science as a reward for her students. It feels like this may be some kind of turning point in the way she views scientific inquiry for the benefit of her students as this was in no way attached to her fourth-grade lesson or plan.
>
> B: While I started packing up and bringing home extras that I didn't think Melissa would want yesterday, the vast majority of materials was going home today. Though I told Melissa that she could have whatever she wanted of my materials, I anticipated that she would be more than ready to be rid of my materials and regain her space. Before I hauled everything out, I double checked with her. To my surprise she did want the supplies and said that she realized just how much fun the kids had with the lessons and that at some time she would do the science again.

While neither Sarah's journal nor the STEBI-B indicate an overall increase in self-efficacy or positive feelings in teaching science, these scenarios indicate that there may have been instances throughout the study where Sarah did in fact feel higher levels of efficaciousness and generally positive feelings about teaching science. These are evident in her efficacious actions of drawing pond water samples, and by her verbal expression to me about wanting to teach science again.

Overarching Qualitative Themes

In examining the overarching themes of this research study, there are some common themes which emerged from both the qualitative analysis of collaborative sessions and the journals entries. These themes were present in both the collaboration transcripts and also in the journal entries.

Stress About Time

One theme which was present in the collaborative sessions but really presented itself in the journals was feeling stressed as it related to the time constraints of the study. This study began in the second semester of the school year. In addition to trying to fit all of the desired measures and lessons into a time span before state-mandated testing occurred in the library, there were additional time constraints which emerged. These were related to both fitting the necessary collaborative planning session into Sarah's schedule, and also fitting the desired inquiry cycle lessons into the 45-minute library fixed-schedule class time. These time constraints weighed on both of us but may have ultimately affected Sarah's overall feelings about the success of the lessons as well as her self-perceived ability to teach science. While Sarah did journal about successes and positive comments made by teachers, these were outweighed by her Feeling Overwhelmed by multiple aspects of the study. The time this study took to create and implement also took away from her other planning times for other grade levels.

Struggles with Making Sense

While it was most apparent in the collaborative session that a great deal of time is necessary to make sense of the environment and expectations of the development of a novel curriculum, these struggles to make sense also appeared in Sarah's journal entries. Sarah struggled to feel comfortable and confident about the implementation of the curriculum. She worried about the long-term ramifications on student discipline in her journals and sometimes stated worry during collaborative sessions that she was doing something that would jeopardize the study. These struggles to make sense may have weighed on her cognitive load during the research and contributed to her feeling Tired and thus contributed to Feeling Overwhelmed.

Lack of Resources

Both the collaborative sessions and the journal entries included instances which discussed a lack of resources. During collaborative planning, books and experiential materials were needed which were not already present in the school but I had anticipated this prior to the research study and already planned to purchase any necessary materials. However, less obviously resources such as staffing, volunteers, and the school library space itself presented resource challenges, which were sometimes unpredictably, removed from the study entirely.

Library Space as a Necessary Resource

A surprising result was the extent to which the library space emerged as a necessary resource to both the study and to library instruction in general. While I anticipated some displacement due to state-mandated testing in the library, when I compared Sarah's and my journals, this theme dominated several entries, especially during the times we were displaced due to the office flooding. In these entries, the displacement from the library space began to more closely align with the code *Lacking Resources.* Not only were the library lessons displaced from the library, but because of the confidential nature of office staff and nurse interactions with parent and students, the library was completely closed for any use by students, teachers, and even the librarian herself. In addition, the office staff relocated in Sarah's office. During my time there I did not observe any effort to also accommodate Sarah within her own office space. Sarah also journaled about this. “We are still on a cart and in the classroom. While this is working ok, I can’t wait to be back in my own space. I feel like I am bothering people by going into the library to get things.” And while it is understandable that the office would need to be relocated into a functional space, what made the library the optimal space? Did this complete shutting down of the library indicate a potential lack of understanding of what the library/librarian provides in terms of services and instruction? Had the flooding been the only instance of displacement, the simple answer to these questions may have been that the space and computers available in the library best met the needs of the office. However, the library was regularly closed for small group testing, state testing, faculty/committee meetings, etc. This regular displacement of the school librarian from her “classroom” raises the issue of the perceived importance of the school library program. This was compounded by at least one instance where classroom teachers, completely independently of Sarah, switched their library class times without discussing it with her first. Other instances occurred which may indicate a lack of understanding about what the school librarian does, like club meetings being “dropped” on Sarah to be conducted in the library at the last minute. Furniture was moved during before-school faculty meetings which were not moved back after the meetings, resulting in library staff and volunteers racing to get tables and chairs back in place, in time for scheduled library classes to begin. More than once, these meetings excluded Sarah from her library space entirely for the duration of the meeting. In addition, for 2-3 days each week, she had no library assistant at all and relied entirely on parent volunteers to assist with general library procedures such as book check-in and checkout, assisting students in finding books, and re-shelving books. These unexpected findings might indicate that the library and the librarian may be seen as expendable resources within the school.

There is a final portion of this research study which is the foundation of the development and implementation of the SSLIM curriculum. Through this last research question, I sought to determine if the students benefited from this extensive, and sometimes stressful, planning and implementation. In the following section I will present the findings from the third, and final, research question to examine any changes in student mean scores on the three measures administered to the student sample.

Student Measures

Research Question 3

How do students' science content knowledge, perceptions about nature of science and scientific inquiry, and ideas about who does science change through information and scientific inquiry lessons in the school library?

The final, yet central, component to this research was to evaluate student change during this study. For this question I utilized three separate quantitative measures: a science inquiry content test created by Sarah and myself, the Draw-A-Scientist Test (DAST), and an abbreviated protocol of the Young Children's Views of Science (YCVS). Each of these measures will be examined, in order, in the following sections.

Science Inquiry Content Test

A science inquiry content test was developed by Sarah and myself to measure the changes in student knowledge about the topics of diversity of scientists and sciences, nature of science, and scientific inquiry which we intended to teach during in the SSLIM lessons. We developed the test using a blueprint to identify the content we deemed most important to measure and the types of information and science inquiry activities we planned to implement. For example, because we wanted to see if student ideas about the diversity of scientists changed, we deemed teaching the diversity of different scientists highly important and included it on both the science inquiry content test, as well as utilized the DAST. Because we deemed nature of science (NOS) and scientific inquiry (SI) important, these concepts were measured on both the science inquiry content test as well as the Young Children's Views of Science (YCVS) protocol.

We originally intended to teach a single lesson on magnets because this was directly tied to the state standards in science. However, later in the planning, this was taken out as we discovered that students had already learned a considerable amount about magnets in the classroom instruction and we felt it might confound our results. As a result, that question was removed from the posttest and from all data analysis. The complete pretest is located in Appendix D and the finalized posttest is located in Appendix E. The following table (Table 19) represents the blueprint we followed during lesson planning to create the science inquiry content test. This is presented, verbatim, in Chapter 3, Table 13 as well.

Table 19

Science Inquiry Content Test Blueprint

Content Outline	Content Question	Knowledge	Total Points	% Pre-test	% Post-test
Different Types of Science/ Scientists	Q2, Q5; Q7; Q 10	Identify that scientists are different genders, backgrounds, and ability levels; there are distinctly different areas of science. (Diversity in Science)	4	36 %	40 %
Where Science Happens	Q 4, Q, 8	Identify that science can happen in various setting. (Scientific Inquiry)	2	18%	20%
Means of Conducting Science	Q1, Q 3, Q9, Q 11	Identify that there are different tools and methods of conducting science depending on the type of science. (nature of	4	36%	40%

		science)			
Magnets* *(removed from post-test)	Q 6	The properties of magnets, electricity, and electromagnets.	1	10%	N/A
Total				100%	100%

Item arrangement was 10 multiple choice questions. Before administering the test to students, I conducted a test check. A team of two outside educational experts first reviewed the test for appropriateness of vocabulary, clarity of directions, and clarity of questions. I then administered this test to two 8-year-old children to establish if there were any terms that they did not understand, or if the format was confusing. Neither check resulted in any changes needing to be made to the science inquiry content test. When we administered the pretest and posttest to the students, the test format was provided in print (on paper), projected onto a screen, and read orally to meet the diverse reading needs of young students.

I conducted an Item Difficulty Index and an Item Discrimination Index on both the pretest and posttest results. The following table (Table 20) presents the results of the Item Analysis for the pretest.

Table 20

Item Analysis Pretest

Item Analysis of Pretest	Lowest 30% of scores	Highest 30% of scores	Difficulty (p)	Discrimination (D)
Question 1	0.1	0.7	0.36	0.6
Question 2	0.5	0.7	0.62	0.2
Question 3	0.2	0.8	0.5	0.6
Question 4	0	0.3	0.13	0.3
Question 5	0.1	0	0.06	-0.1
Question 6	0.1	0.6	0.34	0.5
Question 7	0.4	1	0.75	0.6
Question 8	0.6	1	0.81	0.4
Question 9	0.1	0.2	0.13	0.1
Question 10	0.1	0.8	0.47	0.7

On the science inquiry content pretest, 50% of the questions (1, 2, 3, 6, and 10) were in the moderate range of difficulty (p = .26 -.74). Two questions (7, 8) were in the easy range of difficulty (p = .75 - 1), and three questions (4, 5, 9) were in the difficult range of difficulty (0 - .25). This indicates that there was a good range of questions, with the majority being moderately difficult. The discrimination review of these items indicated that 40% of the questions (1, 3, 7, 10) showed high levels of discrimination (D > .5), 30% of the questions (4,6, 8) showed moderate discrimination (D = .3-.5), 20% of the questions (2, 9) showed low discrimination (D < .3) and one question (5) showed negative discrimination (< 0). There may have been several factors for the reason the discrimination was so high. To begin, this was a pretest, so our lessons teaching these concepts had not yet begun. This may also explain the negative discrimination question, as students may have been guessing. In addition, in this school, science was only taught to students who were proficient in reading/writing and mathematics. Therefore, approximately 50% of the entire second grade (the information was not available for the sample in this research) did not receive science instruction as they were in reading/writing or mathematics remediation during that time. As a result of these combined factors, we deemed this an appropriate pretest measure.

After the completion of the study, I conducted and Item Analysis on the posttest measure. This posttest was identical to the pretest minus the one removed magnet question (this question was also removed from the pretest Item Analysis presented above to avoid confusion.) We administered the posttest in the same manner and in the same formats as the pretest. In the following table (Table 21) I present these results.

Table 21

Item Analysis Posttest

Item Analysis of Posttest	Lowest 30% of scores	Highest 30% of scores	Difficulty (p)	Discrimination (D)
Question 1	0.7	0.9	0.84	0.2
Question 2	0.6	1	0.75	0.4
Question 3	0.5	0.8	0.59	0.3
Question 4	0	0.6	0.34	0.6
Question 5	0.4	1	0.72	0.6
Question 6	0.1	0.9	0.63	0.8
Question 7	0.8	0.9	0.84	0.1
Question 8	0.9	1	0.91	0.1
Question 9	0	0.5	0.19	0.5
Question 10	0.7	0.9	0.81	0.2

On the science inquiry content posttest, 40% of the questions (3, 4, 5, and 6) were in the moderate range of difficulty (p = .26 -.74), 50% of the questions (1, 2, 7, 8, 10) were in the easy range of difficulty (p = .75- 1), and one question (9) was in the difficult range of difficulty (0 - .25). This indicates student knowledge at the time of posttest increased. The discrimination of these items at the time of posttest was 30% of the questions (4, 5, 6) showed high levels of discrimination (D > .5), 30% of the questions (2, 3, 9) showed moderate discrimination (D = .3- .5), and 40% of the questions (1, 7, 8, 10) showed low discrimination (D < .3). There was no negative discrimination at the time of posttest. This indicates that there was still discrimination within the questions, however, it had decreased significantly. In the following section I will present the results of the student test scores, as analyzed by *t* tests.

Science Inquiry Content Test Results

We administered this science inquiry content test before the beginning of any inquiry lessons and then again after the completion of all inquiry lessons, in an effort to measure any change in students' perceptions about the diversity of scientists, the nature of science, and scientific inquiry. While we administered all measurements to all second grade students as portions of the library lessons, the samples of students in the data analyses only included students who returned parental consent forms, submitted assent, and were present in school for both the pretest and posttest measures. For the science inquiry content test, this resulted in a sample of (*n*= 31.) I first analyzed the results using a paired sample *t* test (Tables 22 and 23)

Table 22

Content Test Descriptives

	n	*M*	*SD*	*SEM*
Pretest	31	4.32	1.70	0.305
Posttest	31	6.65	1.70	0.306

Table 23

SI Content Test Paired Sample t *test*

				95% CI				
	M	*SD*	*SE*	Lower	Upper	t	df	Sig. (2-tailed)
Pre-Post	-2.32	1.58	0.28	-2.90	-1.74	-8.191	30	0.000

The content test scores for the pretest measure (*M* = 4.32, *SE* = 0.305) when compared to the content test scores for the posttest measure (*M* = 6.65, *SE* = 0.306), show a significant change in mean scores *t*(30) = -8.191, *p* = 0.000. This indicates that there was an overall increase in the mean test scores of the participating students. To further analyze these data to determine if this change was related to the gender of the students, I conducted an independent sample *t* test (Tables 24 and 25).

Table 24

SI Content Test Group Statistics

		n	*M*	*SD*	*SEM*
Pretest	Male	15	4.67	1.72	0.444
	Female	16	4.00	1.67	0.418
Posttest	Male	15	6.73	1.75	0.452
	Female	16	6.56	1.71	0.428

Table 25

SI Content Test Independent Sample t test by Gender

		Levene's Test		*t* test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tail)	*M* Diff.	*SE* Diff.	95% CI	
									Lower	Upper
Pretest	*Eq. var. assumed*	0	0.993	1.094	29	0.283	0.67	0.609	-0.58	1.91
	Eq.var. not assumed			1.093	28.75	0.283	0.67	0.61	-0.58	1.91
Posttest	*Eq. var. assumed*	0.003	0.956	0.275	29	0.786	0.17	0.622	-1.1	1.44
	Eq.var. not assumed			0.27	28.77	0.786	0.17	0.623	-1.1	1.44

When pretest scores are compared for males (*M* = 4.67, *SE* = 0.444) and females (*M* = 4.00, *SE* = 0.418), there is no statistical significance *t*(29) = 1.09, *p* = 0.993. When posttest scores of males (*M* = 6.73, *SE* = 0.452) are compared to posttest scores of females (*M*= 6.73, *SE* = 0.452) there is also no statistically significant difference in the means, *t*(29) = 0.279, *p* = 0.956, thus, student mean scores increased, regardless of gender. The science inquiry content test was only one of three data sources I utilized to measure student growth. The following section examines the student results of the Draw-A-Scientist Test.

Draw-A-Scientist Test

Students also participated in the Draw-A-Scientist Test (DAST) as a pretest before any science lessons were taught, and again as a posttest after the completion of the SSLIM lessons. The DAST is a test that measures the number of stereotypical images drawn by students when they are asked to draw a scientist. Therefore, a higher score indicates more stereotypical images present within the drawing, where a lower score indicates less stereotypical images within the drawing. My intention of utilizing the DAST was to measure any changes in students' perceptions of who does science and in what types of settings, both before instruction and again after instruction, through student drawings. Due to absences, only 24 students completed both the pretest and posttest, thus eight students were removed from analysis. I scored this measure using the Draw-A-Scientist Checklist (DAST-C) which is located in Appendix C. For this analysis, I began by conducting a paired sample *t*- test to examine any changes in whole group mean scores (Tables 26 and 27).

Table 26

DAST Descriptives

	n	*M*	*SD*	*SEM*
Pretest	24	4.92	1.93	0.394
Posttest	24	4.5	1.67	0.341

Table 27

DAST Paired Sample t test

				95% CI				Sig.
	M	*SD*	*SE*	*LL*	*UL*	t	df	(2-tailed)
Pre-Post	0.42	2.1	0.43	-0.47	1.31	0.97	23	0.342

The Draw-A-Scientist scores for the pretest measure (*M* = 4.91, *SE* = 0.394) when compared to the Draw-A-Scientist posttest measure (*M* = 4.50, *SE* = 0.341), do not show a significant change in mean scores *t*(23) = 0.97, *p* = 0.342. However, when I analyzed these data to compare differences by gender using an independent sample *t* test, some changes emerged.

Table 28

DAST Group Statistics

		n	*M*	*SD*	*SEM*
Pretest	Male	13	5.31	1.65	0.458
	Female	11	4.45	2.21	0.666
Posttest	Male	13	5.23	1.79	0.496
	Female	11	3.64	1.03	0.310

Table 29

DAST Independent Sample t test by Gender

		Levene's		*t* test for Equality of Means						
		F	Sig.	t	df	Sig. (2tail)	*M* Diff.	*SE* Diff.	95% CI	
									Lower	Upper
Pre DAST	*Eq. var. assumed*	1.64	0.213	1.082	22	0.291	0.85	0.788	-0.78	2.49
	Eq. var. not assumed			1.056	18.3	0.305	0.85	0.808	-0.84	2.55
Post DAST	*Eq. var. assumed*	4.33	0.049	2.612	22	0.016	1.59	0.610	0.33	2.86
	Eq. var. not assumed			2.73	19.60	0.013	1.59	0.584	0.37	2.81

It should be noted that because Levene's test of homogeneity was violated for the posttest data, these results are reported from the *equal variances not assumed* row. When pretest scores are compared for males (*M* =5.31, *SE* = 0.458) and females (*M* = 4.45, *SE* = 0.666), there is no statistical significance *t*(23) = 1.08, *p* = 0.291. However when posttest scores for males (*M* = 5.23, *SE* = 0.496) are compared with posttest scores of females (*M*= 3.64, *SE* = 0.310) there is a statistically significant difference in the means, *t*(23) = 2.73, *p* = 0.013, thus, males have significantly higher posttest scores than females, meaning male students had more stereotypical images present in their drawing at the time of the posttest than the female students. This is confirmed through a Between-Subjects Effect test, where posttest scores are used as the dependent variable, showing no significance when compared to pretest scores *p* = 0.246, but significance when compared to gender *p* = 0.032. (Table 30).

Table 30

DAST Between-Subjects Effects

Dependent Variable: Posttest_DAST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Par. Eta Sq.
Corrected Model	18.247a	2	9.124	4.188	0.029	0.285
Intercept	36.258	1	36.258	16.642	0.001	0.442
Pretest_DAST	3.1	1	3.1	1.423	0.246	0.063
Gender	11.536	1	11.536	5.295	0.032	0.201
Error	45.753	21	2.179			
Total	550	24				
Corrected Total	64	23				

a R Squared = .285 (Adjusted R Squared = .217)

Upon further investigation, mean male scores stayed relatively unchanged from pretest to posttest (*M* = 5.31; *M* = 5.23) however the mean female scores started lower and decreased at the time of posttest (*M* = 4.45; *M* = 3.64). Because the DAST is a measure of stereotypical images displayed in student drawings, the decrease in female mean scores indicates that female students used less stereotypical images in their posttest drawings than in their pretest drawings, whereas male students included a similar number of stereotypical images in both measures. Because the female scores decreased, this may indicate that female students' perceptions about who does science and where science happens became less stereotypical, and thus more diverse, at the time of the posttest.

In the following section I have provided two samples of student drawings. Student A (Figure 4) was a male student, Student B (Figure 5) was a female student. Following each set of drawings, I have also included the scoring changes for these students with an explanation of scores.

Student A

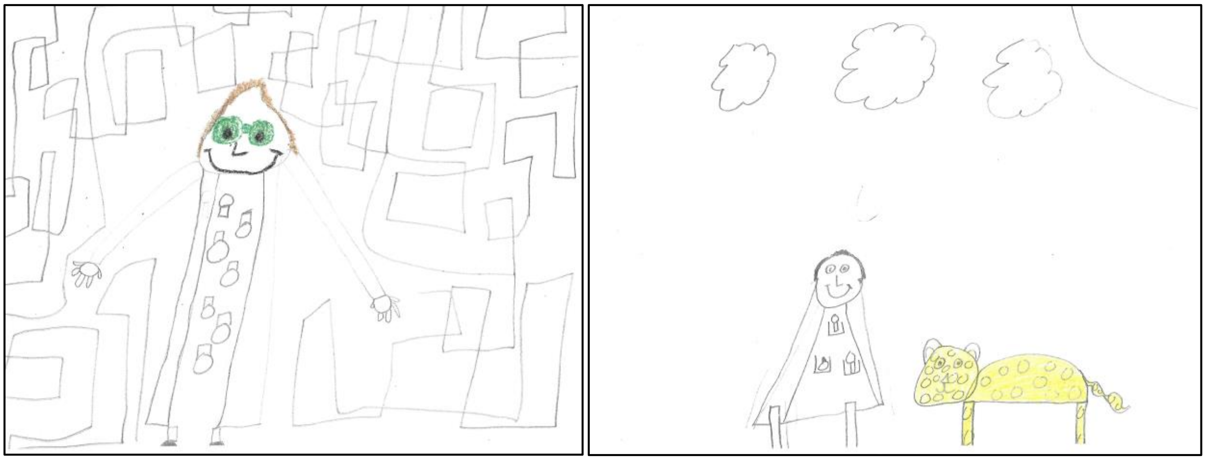

Figure 4. Student “A” pretest DAST and posttest DAST

Student A, technically, only showed a minimal (1 point) decrease in the presence of stereotypical images at the time of posttest. The pretest stereotypical images identified were: lab coat, eyeglasses, symbols of knowledge, male gender, and Caucasian. Because there is no distinct setting in his pretest, I could not determine if that was an indoor setting, so it was not scored as such. However, his posttest image clearly denotes an outdoor setting in a natural environment and working with animals. While the only stereotypical image technically missing from his posttest was the eyeglasses, I believe this comparison still shows a shift in his ideas about what a scientist does, and where science can happen.

Student B

Figure 5. Student “B” pretest DAST and posttest DAST

Student B showed a significant decrease in the presence of stereotypical images at the time of posttest. In her pretest image, the stereotypical images identified were: lab coat, eyeglasses, symbols of research, male gender, Caucasian, doing work indoors, and middle-aged. At the time of posttest, the stereotypical images were: eyeglasses, symbols of research, male gender, and Caucasian. The DAST-C specifically addresses the scoring of multiple scientists.

> If multiple images of persons appear, such as a group of scientists, mark for any and all stereotypical images that are present. (Note: If one member of the group is male and one is female, record a mark in “male gender” but note the presence of the female in item #16.) (Appendix C)

So, while she did include a female image in her posttest, since she also included a male, this remains a counted stereotypical image in the statistical analysis as #16 is simply a section for notes and not included in the analysis. However, this student showed almost a complete change in her portrayal of who does science and where science happens.

While the DAST along with the DAST-C provide a means to statistically quantify the student drawings, as can be seen with these samples, it does not comprehensively address change which can be seen in the drawings themselves. A final measure of student growth was measured utilizing an abbreviated version of the Young Children's Views of Science interview protocol. This is examined in the following section.

Young Children's Views of Science

Students participated in an abbreviated version of the Young Children's Views of Science (YCVS) protocol, as a pretest and posttest measure. The YCVS is a small group interview in which students are asked questions about nature of science (NOS) and scientific inquiry (SI) through scenarios and demonstrations. The complete protocol is located in Appendix F. However, due to time constraints, the protocol was significantly abbreviated for this study. This abbreviated protocol consisted of five questions which are located in Appendix G. Scoring for the YCVS is based on the students' ability to demonstrate knowledge about NOS and SI through their answers to the questions. I scored each question with "Novice" answers with a score of 0, and "Informed" answers a score of 1. Incomplete and unanswered questions were also given a score of 0. All students in the sample were present for both pretest and posttest for this measure (*n*=32). I began my analysis with a paired sample t test (Tables 31 and 32).

Table 31

YCVS Descriptives

	n	*M*	*SD*	*SEM*
Pretest	32	2.72	1.33	0.234
Posttest	32	3.78	1.01	0.178

Table 32

YCVS Paired Sample t test

	M	*SD*	*SE*	95% CI *LL*	95% CI *UL*	t	df	Sig. (2-tailed)
Pre-Post	-1.06	1.13	0.2	-1.47	-0.65	-5.3	31	0.000

The YCVS scores for the pretest interviews (*M* = 2.72, *SE* = 0.234) when compared to the YCVS posttest interviews (*M* = 3.781, *SE* = 0.178), show a significant change in mean scores *t*(31) = -5.299, *p* = 0.000. This indicates that there was an increase in the students' ability to verbalize correct and informed concepts about the NOS and SI in answers to the interview questions, at the time of the posttest. To further analyze these data to determine if these improvements differed by gender, I conducted an independent sample *t* test (Tables 33 and 34).

Table 33

YCVS Group Statistics

		n	*M*	*SD*	*SEM*
Pretest	Male	16	2.69	1.25	0.313
	Female	16	2.75	1.44	0.359
Posttest	Male	16	3.63	1.02	0.256
	Female	16	3.94	1	0.249

Table 34

YCVS Independent Sample t test by Gender

		Levene's		*t* test for Equality of Means						
		F	Sig.	t	df	Sig. (2tail)	*M* Diff.	*SE* Diff.	95% CI Lower	95% CI Upper
Pretest	*Eq. var. assumed*	0.06	0.811	-0.13	30	0.896	-0.06	0.476	-1.04	0.91
	Eq. var. not assumed			-0.13	29.43	0.896	-0.06	0.476	-1.04	0.91
Posttest	*Eq. var. assumed*	0.09	0.765	-0.87	30	0.389	-0.31	0.358	-1.04	0.42
	Eq. var. not assumed			-0.87	29.98	0.389	-0.31	0.358	-1.04	0.42

When pretest scores are compared for males (*M* = 2.69, *SE* = 0.313) and females (*M* = 2.75, *SE* = 0.359), there is no statistical significance *t*(30) = -.131, *p* = 0.896 in mean scores by gender. When posttest scores of males (*M* = 3.63, *SE* = 0.256) are compared to posttest scores of females (*M*= 3.94, *SE* = 0.249) there is also no statistically significant difference in the mean scores by gender, *t*(30) = -0.874, *p* = 0.389, thus, the increase in correct answers was not significantly related to a specific gender. This indicates that both male and female students showed an overall increase in the ability to verbalize concepts of nature of science and scientific inquiry, at the time of posttest.

Surprising Results

When students were interviewed using the modified YCVS protocol, I noticed an interesting occurrence. I observed students "piggybacking" on other student responses. Many of these were understandable, even expected, for students who may not have had a concrete self-developed answer. These common occurrences were presented as statements such as "I agree with what she said" or "Me too." However, some more extensive examples in answers occurred as well. For example, during the pretest of one group the scenario was presented to the students about a lady who loved birds (question #4 in Appendix G). This scenario only presents information about her observations of birds, their beaks, and that they eat different foods, then asks questions about how she is/is not working like a scientist. There is nothing in this scenario about baby birds, yet in one group, a student started talking about baby birds and how the mother would feed them, which was later picked up by another student.

> "Because if the beaks were – if they were baby birds they ate worms just like the mom and dad and they have little beaks and tall beaks."

The next student recorded within that group answered within the parameters of the question, however, the following student picked up this "story" of the baby birds and continued the narrative, answering the question further in relation to how the mother would feed the birds.

> "Yes, because she was asking questions and if the baby birds if they have all the same beaks they won't have to eat the little food and it doesn't have to be all chewed up."

A similar instance happened in a longer chain of students but in a different group and at the time of the posttest. In this segment, they were asked, "what should she do next to answer her question?" Keeping in mind the scenario discussed how the lady who loved birds noticed how the birds had different beaks and ate different types of foods, this new "story" developed and progressed with three students.

Student 1: "She should get a bird and take it back to her home and discover them."

Student 2 answers within the parameters of the question:

> "She should get a few birds and she should test and touch their beak if they let her and feed them different foods and see if they eat them."

Where student 3 revisits and elaborates on this idea of taking a bird home with her, presented by the first student:

> "I think that she could take a bird home and she could keep it as a pet so maybe she could discover a new species of bird or take two different birds and have…and they can lay an egg and then they can see if, and then she can see whether it's the male one or the female bird or it was a mix between the two birds."

This is followed by the fourth student who appears to synthesize the previous answer:

> "I think that she can just get two birds and do a scientific experiment to see if they can put those two birds together to create a new type of bird to eat different foods."

This did not only happen with the bird scenario. A similar instance happened in a different group when asked what they could tell me about science or scientists (question #1 in Appendix G). One student started talking about an experiment with Mentos.

> “That like if a scientist has a volcano and they put lava and they put this thing in it and then they put Mentos in it and then it would explode and it would be so cool.”

Again, the next student answered within the parameters of the question

> “I learned that some scientists make plants.”

But the following student again picked up on the Mentos story.

> “Well when I was in the house I was on the internet and so I went outside on my computer and I tried this skill and it was kind of like his but I went to the store and I got some soda and then I got Mentos and put it in there and it exploded everywhere and I drank it.”

It is entirely possible that both students had seen or experimented with Mentos in soda. However, it is interesting that some of the students seemed to formulate their answers based on previous student stories, rather than the question or scenario presented to them. There are additional examples of this in both the pretest and posttest groups, although others are more commonly less specific and tended toward talk about potions, infallibility, and other common misconceptions in science. This continuation of story was not formally analyzed for this research study and is only provided as an observation which may warrant a more in-depth investigation into how students gather and formulate information within a group setting. In addition, it may be valuable to know if small group interviews, such as these, can cause students to alter their answers, and therefore the analysis results, when compared to answers provided in one-on-one interviews.

Student Results

Mean student scores, regardless of gender, increased for the science inquiry content test. Because the science inquiry content test was the same measure repeated, students could have scored higher due to learning effect. However, there were over three months between the administration of the tests, and the students were never directly given the correct answers to the pretest. Also, as aforementioned, some of the students in the sample may not have received any, or minimal, classroom science instruction prior to the science in the library lessons, thus potentially intensifying the posttest results for those students.

The Young Children’s Views of Science also showed a statistically significant increase in “Informed” student responses at the time of the posttests. In addition to learning effect, a possible reason for this may have been related to comfort levels with me at the time of pretest versus posttest. Some of the children seemed visibly shy during the pretest interview, where none appeared that way at the time of the posttest interview. However, when the recordings from my groups of pretest interviews were compared to Sarah’s groups of pretest interviews, students showed similar levels of participation, hesitation, and ability to answer the questions. In addition, Sarah’s groups scored comparably to my groups at the time of pretest. Posttests were conducted solely by me in the classrooms after the completion of the SSLIM lessons because state-mandated testing was scheduled in the library and Sarah was teaching in other classrooms.

The Draw-A-Scientist Test did not show statistically significant overall change in whole sample mean scores from pretest to posttest. However, when separated by gender female students showed a statistically significant decrease in scores. This indicates that, because this is a measure of stereotypical images of scientists, females drew more diverse and less stereotypical images of scientists at the time of posttest, where males stayed nearly unchanged with the mean score only decreasing by 0.08.

Conclusion

In review, this chapter looked at the qualitative and quantitative measures applied to this research study and results from those analyses. In this chapter, I presented the findings from the collaborative sessions and the ways that the patterns of collaboration change and overlap during the creation of a novel information and science inquiry curriculum. Furthermore, I examined how talk about Learners changed throughout the course of the collaborative session and how that talk was interwoven with Making Connections, as we built the lesson plans directly around students' expressed interests in the learner-centered design. I also presented the results from the Science Teacher Efficacy Belief Instrument (STEBI-B), as well as examined the librarian's journals. These data sources combined indicate that there was little change in Sarah's self-efficacy in teaching science and that her negative feelings may have increased over time. However, entries in my own journals indicate that there may have been instances during the study where Sara did experience efficaciousness and positive feelings about teaching science. I then examined both qualitative portions of the study to determine themes that emerged when they were compared. This comparison showed that a main theme throughout collaboration and journaling was stress about time. In both sets of data Sarah and I mutually expressed feeling about the stress of getting everything accomplished within the time frame of the study. Additionally, we both struggled with making sense of the curriculum we were creating, however, Sarah also voiced and journaled about her unsureness and feelings of jeopardizing the study. Finally, the common theme of lacking resources emerged. At the basic level, this looked like ordering and locating necessary materials for the lessons. However, the surprising theme of the library as a resource emerged when we were displaced from the library. Upon further investigation, I found instances where Sarah was regularly displaced from the library space for meetings and testing. This displacement, along with other instances of perceived lack of understanding about the librarian's role in the school, may indicate that in some settings the school librarian and the school library are considered more of an optional resource within the school than a necessary program and support.

Finally, I presented the results from three student measures and the statistical significance of each. Two of the measures (science inquiry content test and the Young Children's Views of Science) showed statistically significant growth for the student sample as a whole, while one measure (Draw-A-Scientist Test) only show statistically significant growth for female students. This may indicate that while the process of creating this curriculum was generally very time consuming, often stressful, and sometimes confusing, that the implementation of this curriculum showed student improvement in designated science concepts. Furthermore, this type of learner-centered science and information inquiry curriculum can be successfully implemented in a fixed-library schedule and produce positive student results.

In Chapter 5, I will present an overview of the entire research study and present conclusions and discussions that resulted from this research. I will review the findings as they relate to the larger bodies of research. I will also provide a more comprehensive look at the limitations and delimitations of this research study. Finally, I will address the implications and recommendations for future research.

CHAPTER 5

DISCUSSION AND CONCLUSION

In this chapter I will further discuss the findings from the previous chapters and draw conclusions about how the Science in the Library Inquiry Model (SSLIM) curriculum, a novel, information and science inquiry curriculum, was created and implemented into a fixed schedule elementary school library, and how that implementation affected the school librarian's, and the participating students' perceptions of science.

Summary of the Study

In this research study, I presented problems within the US educational system in two marginalized areas of the elementary school: science education and library programs. By utilizing the school library as an optimal space for inquiry investigations, the school librarian may be in an ideal position and space to teach inquiry science as a support to classroom instruction, while simultaneously meeting information literacy goals of the library program. The results from this research study indicate that the use of a dual science and information inquiry cycle and curriculum, set in a constructivist environment, provided positive student results.

Purpose

The purpose of this mixed-method, case study research was to explore the development of a Science in the School Library Inquiry Model (SSLIM) curriculum which leveraged the synergies between science and library instruction. In this study, I examined the collaborative development and implementation of a curriculum that supported second-grade student science learning in the areas of nature of science (NOS), scientific inquiry (SI), and the diversity of scientists, while simultaneously supporting information literacy through inquiry. I collected qualitative data through nine collaborative planning sessions and librarian and researcher journals. I examined the effects this curriculum development had on the school librarian's efficacy and feelings about teaching science. Additionally, I collected quantitative data through three student measures: The Draw-A-Scientist Test (DAST), the Young Children's Views of Science (YCVS) protocol, and a science inquiry content test, as well as through one librarian measure, the Science Teacher Efficacy Belief Instrument (STEBI-B). Data collection and analyses were guided by the following research questions.

Research Questions

1) How do an elementary school librarian and an educational researcher, collaboratively plan and implement a learner-centered information and science inquiry curriculum for second-grade students in the school library?
2) How does the development and implementation of this curriculum affect the school librarian's feelings and self-efficacy of teaching science?
3) How do students' science content knowledge, perceptions about nature of science and scientific inquiry, and ideas about who does science change through information and scientific inquiry lessons in the school library?

In Chapter 2, I presented a review of the literature which examined the commonalities between these subjects. This was initially examined through a comparison of *AASL Standards Framework for Learners* (American Association of School Librarians, 2018b) and the *Next Generation Science Standards* (NGSS Lead States, 2013). A side-by-side chart was presented which compared common verbiage and goals within the science and library standards and showed how similar these national standards are. This was followed by a comparison of two commonly used inquiry cycles in library science and science instruction. The school library inquiry cycle presented was Guided Inquiry (Kuhlthau, Maniotes, Caspari, 2007; 2015) and the science inquiry model presented was the BSCS 5E Instructional Model (Bybee, et al, 2006). Each of these inquiry models are commonly accepted and used in their respective fields. They were each examined by inquiry stage, broken down, and compared side-by-side to further examine the commonalities present.

The similar inquiry models were combined into a new and unique inquiry model, named the Science in the School Library Inquiry Model (SSLIM). The SSLIM combines the similar, as well as the unique, components of Guided Inquiry (Kuhlthau, Maniotes, Caspari, 2007; 2015), and BSCS 5E Model (Bybee, et al, 2006) to create five new phases of inquiry: Involve, Enquire, Inquire (Library), Inquire (Science), and Elaborate. The SSLIM engaged the students in the larger science topic through group reading and discussion activities (*Involve*). This was followed by *Enquire*, where students created their own specific inquiry questions within the larger science topic. In the next stage, the students looked up preliminary information about their inquiry question(s) in literature and other non-fiction materials present in the school library (*Inquire - Library*). Once they attained answers or preliminary information, they moved on to *Inquire – Science* where they choose an experiential station (or stations) to test out and problem solve their question. Students recorded questions and answers throughout the inquiry process. Finally, students shared their findings with other students (*Elaborate*).

The review of literature then progressed to examine other commonalities between the library and science. Commonalities included overlapping goals in utilizing quality literature to best educate students, and how using quality science trade books can aid in science instruction. It also looked at commonalities in marginalization each discipline is facing. In libraries, it is often due to restrictive schedules and, more importantly, the ongoing trend in cutting school library positions nationwide (Lance, 2018). While research has indicated time and again that the presence of a certified school librarian positively correlates to higher test scores (Gaver, 1961; Lance, 1992; Library Research Service, 2013), school library positions have continued to undergo extreme cuts in positions over the past two decades (Lance, 2018). In science, this marginalization is often due to time constraints caused by testing demands (Griffith & Scharmann, 2008), and lack of teacher knowledge/efficacy (Appleton, 2003; Rawson, Anderson, & Hughes-Hassell, 2015). Because of these issues, science often takes a backseat to more heavily tested subjects such as language arts and mathematics. Science scores were the lowest in elementary school students in the three tested areas of language arts, mathematics, and science, in a recent longitudinal study (Mulligan, McCarroll, Flanagan, & Potter, 2014; 2015; 2016; 2018), with results over four years presented. These trends continue into Middle School (National Center for Education Statistics, 2018) and High School (National Center for Education Statistics, 2018) and are present in ACT (ACT, 2016) scores nationwide and PISA (OECD, 2018) scores as compared to other countries. Testing demands are compounded with the lack of efficacy of general education teachers, as seen in elementary schools, which can also hinder instruction (Appleton, 2003; Rawson, Anderson, & Hughes-Hassell, 2015). This lack of efficacy in teaching science affects not only classroom teachers, but school librarians as well (Mardis, 2007; Schultz-Jones & Ledbetter, 2009; Rawson, Anderson, & Hughes-Hassell, 2015). Ultimately, it is the student that may be most affected by this lack of time, perceived importance, and efficacy of science instruction, and while it is commonly accepted that students have formed a solid opinion about science by the time they exit elementary school (Archer, Dewitt, Osborne, Dillon, Willis & Wong, 2010; Murphy & Beggs, 2005), some research indicates it may start earlier, even as early as kindergarten (Patrick, Mantzicopoulos, & Samarapungavan, 2008). However, research also indicates that negative perceptions about science, by young students, can be altered and sometimes negated by relatively small interventions of specific science instruction (Patrick, Mantzicopoulos and Samarapungavan, 2008; Sharkawy, 2012).

One way that could prove beneficial to both teachers and librarians in the elementary school setting, is regular collaboration between school librarians and classroom teachers to develop meaningful inquiry science instruction. Research indicates that this type of collaboration works over time and increases teacher and librarian comfort and efficacy in teaching inquiry science (Montiel-Overall and Grimes, 2013). However, the constraints of fixed-schedule libraries, which make up over 30% of elementary school libraries (Bitterman, Gray, & Goldring, 2013), poses a problem to regular in-school collaboration, as school librarians are often treated as a resource during the classroom teachers' set planning time (Gavigan, Pribesh & Dickinson, 2010). In this research study, I looked at a librarian in a fixed-library schedule, with the lesson planning and collaboration limited to the librarian and myself as participant-researcher to explore how inquiry information and science lessons can be implemented during these fixed library class times.

I rooted this research study in the theoretical framework of Constructivism, specifically the theories of teaching the early childhood classrooms set forth by Montessori (1995) and Vygotsky (1978). I focused on the idea that students should be agents in their own learning and active participants in making choices about their learning. Through this study, I sought to examine if planning and implementing these lessons changed the self-efficacy (Bandura, 1977) of the school librarian in teaching science. These theories were nestled within the Learner-Centered Ideology (Schiro, 2013) where the students, quite literally, have a voice in what is taught in the classroom and what they choose to learn about within the larger planned curriculum. These theoretical frameworks and ideology were the foundation from which the school librarian and I planned and built the lessons in this research study.

In chapter 3, I presented the mixed-methods case study which I conducted in one elementary school library, in which the school librarian and myself as participant-researcher, developed a unique learner-centered, information and science inquiry curriculum with second-grade students. I employed a variety of measures and data collection techniques to examine how the curriculum was created and implemented, the effects it had on the school librarian's self-efficacy and feelings about teaching the science lessons, and the change of student science scores using three different pretest/posttest measures.

In answering the first research question, "How do an elementary school librarian and an educational researcher, collaboratively plan and implement a learner-centered, information and science inquiry curriculum for second-grade students in the school library?" I utilized over nine hours of recorded and transcribed collaborative sessions between the school librarian and myself. I deductively coded the transcriptions using Kimmel's (2012) codes of collaborative patterns. Changes in the meanings of the codes were addressed and an additional code of *Learner* was added. This was done to more fully examine the amount of time we spent talking about students, as they were contributors to the learner-centered instruction and indirect members of the collaborative planning process. During these collaborative sessions we established a schedule, we developed an outline of the different topics we would teach, determined the diverse scientists the lessons would be tied to, and the materials we would use in the experiential stations.

Research question 2 was analyzed using the Science Teacher Efficacy Belief Instrument (STEBI-B), and nightly journals kept by the school librarian. I also kept a researcher journal to record activities, lessons, and notes about what went on during the day, but also as a way to examine common thoughts between the journals to develop a set of codes common to both. I used open-coding on both journals which resulted in 15 initial codes. These codes went through several phases of revisions, collapsing, re-coding, and were revised again. These revisions were done by me, and also through discussions with outside educational experts, in an effort to increase inter-rater reliability. Once codes were combined and revised, an inter-rater agreeance of 91% was established. I also utilized the STEBI-B to see if there were any changes in the school librarian's efficacy beliefs or outcome expectancies from before the implementation of the research study to after the research study was completed. The STEBI-B is a 25 question Likert style scale where participants self- report their feelings about teaching science, how they believe students learn, and how much impact they believe their science teaching has on student science learning. The complete instrument is located in Appendix B.

For research question 3, I utilized three different pretest/posttest measures to determine change in students' perceptions of science, who does science, scientific inquiry and nature of science. This began with the Draw-A-Scientist Test (DAST) which we administered before any science instruction or other pretests began. This is a measure of stereotypical images drawn by students when they are asked to "draw a scientist." The students had 10-minutes to complete this task. I scored the drawings using the Draw-A-Scientist Checklist (DAST-C) located in Appendix C. Scoring was verified at 95% inter-rater reliability with two educational specialists. We then administered the science inquiry content test to students, which was developed by the librarian and myself to specifically address topics and themes we intended to teach in the SSLIM lessons. We developed this content test using a blueprint and guided by nature of science and scientific inquiry principals as well as the diversity of science and scientists. We administered this test to the students on paper, with the identical test projected on a screen, and read aloud as well. Finally, we administered an abbreviated version of the Young Children's Views of Science (YCVS) instrument with the students. The complete instrument can be found in Appendix F and the revised version can be found in Appendix G. The YCVS is a small group interview utilizing scenarios and demonstrations to elicit student responses to scientific inquiry (SI) and nature of science (NOS) questions. These interviews were conducted by both the librarian and myself before any Science in the School Library Inquiry Model (SSLIM) instruction began. All pretests were administered again by one or both of us after the completion of all SSLIM lessons as a means of posttest data.

In Chapter 4 I presented the results of each of the measures presented in Chapter 3. For research question 1, I analyzed each collaborative session to examine changes in these processes of Coordinating, Making Sense, Drifting, Orienting, Making Connections and Learners over the span of the collaborative planning session, as well as looked at how the code of Learner interacted other themes and codes. Making Connections eventually encompassed the majority of talk about Learners as we explicitly developed the curriculum and the lessons to student interests. Results also indicated that a significant amount of time was necessary Making Sense of the setting, standards, and research objectives in the initial phases of the research. This eventually changed over time to significantly shift to Making Connection to resources and building lessons explicitly around student voiced interests.

For research question 2, I presented the results of the analysis of the librarian's (Sarah's) journals and my journals, which were analyzed through open-coding and developed into five main themes: Talk about Students, Problems with Time, Resources Needed, Planning and Implementing Lessons, and Feelings. Because in this research question I specifically addressed the librarian's feelings and efficacy about teaching science, I utilized her journal entries for further analysis of her feelings and how often these feeling were presented throughout her journal entries. The results showed the there was a high rate occurrence of Feeling Overwhelmed. In addition, Feeling Overwhelmed often coincided with Problems with Time. This interaction indicated that time pressures may have affected Sarah's feelings about being overwhelmed throughout the research study. When analyzed over time, there was no significant decrease in her expression of these overwhelmed feelings, nor an increase of Positive Feelings thus indicating that the librarian consistently stated feelings of being overwhelmed throughout the research process, with little to no increase in expressions of positive feelings. As another means of measurement and verification, the Science Teacher Efficacy Belief Instrument (STEBI-B) was administered to the school librarian before any portion of the research study began and again after the research study was completed. Through a paired sample *t* test and then an independent sample *t* test, the STEBI-B confirmed that there was no significant change in her overall science teaching efficacy, nor was there a significant change in her efficacy belief or outcome expectancy when they were analyzed separately.

For research question 3, I presented the results of the science inquiry content test and the Young Children's Views of Science (YCVS) instrument, which both utilized a paired sample *t* test to analyze pretest and posttest mean scores in the student sample. Both indicated statistically significant increases in students' knowledge of nature of science and scientific inquiry. The science inquiry content test also measured perceptions about who can do science. This aligned with the Draw-A-Scientist-Test (DAST) as well. I analyzed the mean results of the DAST through a paired sample *t* test, which showed no significant changes in the number of stereotypical images that the students drew as a group. However, when I separated the data by gender in an independent sample *t* test, I was discovered that girls scored lower than boys at the time of posttest. This indicates that after instruction, girls drew less stereotypical, and thus more diverse, images of scientists where the boys' images stayed very similar to the pretest measure in terms of the number of stereotypical images drawn.

Return to the Theoretical Framework

In this research study I utilized the learner-center ideology, constructivism and self-efficacy to guide the creation of the research design. The writings of Vygotsky and Montessori both support the necessity of students having agency in their learning, and that the constructivist environment is the most effective environment for student learning. The results from this research indicate that the students did, in fact, succeed within this environment. Students successfully learned concrete science concepts through independent, learner-driven, investigations within the constructivist environment where they were encouraged to explore concepts at their own pace and based on their own interests. During this process, students were not taught the same exact lessons in a step-by-step process, yet they learned the concepts of nature of science and scientific inquiry while simultaneously engaging in library inquiry activities. Furthermore, the library proved an optimal space to allow students to explore the non-fiction books, and hands-on investigations, freely and based on their own interests and questions.

Measured changes in self-efficacy were not apparent in this study. Bandura theorizes that a person's self-perceived belief in their ability to accomplish a task directly affects their outcome in accomplishing that task. While I had hoped the development and implementation of the lessons would increase Sarah's self-efficacy in teaching science, her uncertainty throughout the research study likely affected this lack of change in her self-efficacy. However, while the lessons did not produce an increase in self-efficacy as anticipated, there were indications that the research may still have, in some ways, altered her ideas about teaching science in a positive way.

These indications were evident in her desire to keep the science materials after the completion of the research study for future library lessons, and also by using the microscopes as a reward for her fourth grade classes. Overall, while there were some unforeseen issues with this research study, I conclude that overall the SSLIM lessons were a success in supporting the science curriculum, and that the school librarian can be a support to science learning and the library is indeed a place where experiential science instruction can successfully occur.

Overarching Themes as they Relate to the Literature

Collaboration

Research examining long-term collaboration between school librarians and teachers in the elementary school setting is sparse. There are two significant research studies which warrant comparison. The first is Kimmel's (2012) research which examined a year of collaboration between a school librarian and second-grade teachers in her school. Kimmel presented five main themes (patterns) of collaboration. I used these patterns as the foundation for collaboration coding in this research study. It should be noted that the meaning of the codes shifted in this research study, and an additional theme of Learners was expanded to look explicitly at how much of our planning was directly related to students. This research study supports Kimmel's conclusions about common patterns that are present in collaboration, even when the format of the collaboration in the research study differs.

Another significant study on librarian collaboration was conducted by Montiel-Overall and Grimes (2013) which examined a two-year longitudinal study of the stages of collaborative planning, of inquiry-based science instruction, through weekly Professional Development meetings. In this research, Montiel-Overall and Grimes concluded that there are four themes that emerged when librarians, teachers, and peer mentors worked together to develop lessons which included inquiry science, library information literacy skills, as well as language skills for emerging ESL readers. These themes were: *Preparation, Experience, Transformation*, and *Motivation*. Preparation is “needed information to prepare them for teaching and thinking in new ways, including TLC and inquiry-based instruction” (p. 45). Experience is “hands-on experience collaborating as a cohort...” (p. 46). Transformation is “…a change in pedagogy as they became more familiar with inquiry-based science methods focused on student questions… They learned to guide students through observation, experimentation, and library research” (p. 46). Motivation is “increased motivation in teaching science and increased interest by students” (p. 46). While Preparation, Experience, and Transformation were evident themes in my research study as well, there is little evidence that Sarah moved into the Motivation phase. This may be due to the limited amount of time we collaborated, as compared to Montiel-Overall’s and Grimes’ final two-year timeline. As a result, I examined the preliminary results from the first year of their research study. The initial categories from the first year of the Montiel-Overall and Grimes (2013) study appear to more closely resemble the results from my research study. “Initial categories included building relationships, sharing curriculum, making connections, changing perceptions, and changing teaching” (p. 45).

Our collaborative sessions, though they differed in structure and participants, closely resembled those presented in previous collaboration research studies of comparable time spans but failed to reach the more advanced stage which might have been achieved through more time. This may indicate that there are mutually common phases of collaborative planning, which may change and transform over time, and that certain levels of collaboration may only be attained with sustained and consistent collaboration over an extended span of time. This regularity and extended span of time was not achieved in the planning of the SSLIM curriculum but had time allowed, may have eventually progressed and developed into a higher level of collaboration resulting in self-motivation based on positive student results. In turn, this may have had the potential to affect Sarah's feeling of self-efficacy in teaching science and her feelings about the creation and planning of the SSLIM lessons.

Student Results

When looking at student results, it appears that the students did benefit from this research study. As a whole, the student sample showed a statistically significant increase in nature of science, scientific inquiry, and the diversity of scientists and science. The Young Children's Views of Science (YCVS) results in this research study support the positive results published by Lederman, Bartels, Lederman, & Gnanakkan, (2014). These results indicate that when students are explicitly taught about nature of science (NOS) and scientific inquiry (SI), their ability to provide informed answers about NOS and SI at the time of posttest increases.

Additionally, The Draw-A-Scientist Test results for this research are in line with a recently published meta-analysis on the DAST (Miller, Nolla, Eagly, & Uttal, 2018) which indicates that over the last five decades girls are more likely to draw women when asked to draw a scientist. However, in reviewing the data from the DAST in this research study, it is inconclusive as to why female students' drawing changed so much more significantly than those of the male students. While the original format of the DAST was utilized in this research paper, research since Chamber's (1983) original measurement development has suggested that the use of additional reflection questions, administered to the students after they complete the drawings, may provide more insight into the meanings of the drawings (Cakmakci, Tosun, Turgut, Orenler, Sengul, & Top, 2011). These additional questions may have significantly contributed to my understanding of this gender gap.

Library Space as a Needed Resource

A surprising result that emerged from the cross-analysis of the collaborative sessions and the librarian and researcher journals was extent to which the library space, itself, was a necessary, but sometimes unavailable, resource to instruction. While it may seem that the "classroom" space of the librarian (the library) would be necessary to effectively teach, Sarah was regularly displaced from her library for testing, meetings, and during a relocation of the office and nursing staff, due to flooding in the main office. During these times she was excluded from the space and had to teach in classrooms from a cart of books and materials. In addition to this, there were other instances that arose which brought into question the understanding within the school about the library program and perceptions of the importance of library instruction. These were instances where teachers moved library class times without informing Sarah ahead of time, the co-sponsor for SCA unexpectedly left her with club responsibilities to handle in the morning which impacted instructional time, as well as tables and chairs being moved during before school day meetings, which were left in disarray. Because of the fixed-library schedule, second-grade classes began promptly after these meetings, resulting in a rush to get the library set up correctly for instruction. Finally, during the relocation of the office, the office staff took over the library, as well as Sarah's office space, with no personally observed effort to accommodate Sarah as well within that space. All of these instances point to the possibility that the school library program may have been viewed as expendable within certain portions of the school community. This lack of understanding about the responsibilities of the school librarian may be consistent with the research by Schultz-Jones and Ledbetter (2009) which indicated that secondary science teachers interviewed did not know what the school librarian did, or that the school librarians were certified teachers. This warrants further research to determine if these misconceptions and lack of understanding about the responsibilities of the school librarian extend to general education teachers and administrators as well.

Implications for Action

Through this research, I presented preliminary evidence which indicates that the school librarian, with mentorship, can teach science and information inquiry lessons in the library, and that these lessons can effectively support the science curriculum and raise student knowledge of nature of science, scientific inquiry, and the diversity of science and scientists. This preliminary evidence may inform librarians, library supervisors, administrators, and educators of school librarians about ways the librarian can supplement non-traditional content subjects, such as science, within school library instruction. School librarians, school administrators, and library supervisors are encouraged to also look at alternative ways that school librarians can contribute to the various subjects in the school curricula through lessons such as these, but to keep in mind the dedicated time and collaboration these types of lessons require. Furthermore, administrators and supervisors of libraries in fixed-schedules are encouraged to revisit the benefits of an open schedule in the library which would allow for librarians to actively participate in grade level and/or content meetings and allow for flexibility of class times and duration to best meet student needs. In addition, educators of school librarians are encouraged to examine the additional needs of preservice school librarians, as generalists within the school, and to examine areas of self-perceived weaknesses in an effort to better identify and prepare preservice school librarians for collaboration and instruction in a variety of content areas. Finally, all audiences should evaluate the role the school librarian can play in authentic inquiry, and how science and library standards and inquiry cycles can support each other.

Research looking at the school librarian as a certified teacher who can help support and improve student test scores in underrepresented subjects such as science, may provide much needed empirical data on the importance of schools retaining a certified school librarian. While the results from research study indicated positive student results in each student measurement, the amount of time necessary to plan this curriculum from scratch may be impractical for replication. Science kits such as those produced by FOSS are often available for classroom instruction, though, these types of kits may also prove beneficial for librarians to conduct supplementary science instruction in the library. However, in an effort to meet national library standards, these types of resources would need to be supplemented with appropriate literature and aligned to library inquiry cycles as well.

Finally, the theme of the library space as a necessary, and sometimes unavailable, resource repeatedly presented itself in this research study. The school librarian's "classroom" was often closed to students, teachers, and the librarian herself. While a teacher's classroom may be a resource which is taken for granted as it is an implied necessity for instruction, the librarian's "classroom" of the library was often unavailable to her. This may be reality shared by other school librarians. Libraries may be closed to the librarian and to library lessons for testing or meetings. Furniture may be moved and not replaced. Access to resources may be limited to both patrons and the librarian herself. This may be, at least in part, due to a lack of understanding that the librarian is a certified teacher, and the school library is her classroom. This warrants a more in-depth look into the ways that administrators and elementary classroom teachers view the roles and responsibilities of the school librarian within the elementary school.

Reflection on the Process

There were several instances during this research that changed the course of the study. Through reflection, I hope to provide insight for future researchers. Given the opportunity, these are things I would do differently if I were to replicate this research study.

Curriculum

I would recommend a simplified curriculum. The development of this curriculum took a great deal of time and energy, much more than I had anticipated. The continued stress of this time and how it impacted other responsibilities, such as planning for other classes, was present in Sarah's journals. I would recommend utilizing an already established curriculum to build upon in future research. This would remove a great deal of time, and thus stress, from the librarian. An experiential science curriculum may be a good place to start.

Collaborator

While an original aspiration of mine was to demonstrate that this was "doable" at any level of science teaching comfort, this was not evident in the results. My own experience and comfort with science likely brought a biased view about the ease of science instruction into the research. In future research endeavors, I would choose a librarian who was already comfortable teaching experiential science and possibly already played an active role in that type of instruction within the school. Additionally, I would recommend to future researchers to establish a specific collaboration time, which is agreed upon by all parties involved, and adhere to it.

Researcher

During this research study I did not think to alter my researcher journaling as the context changed from my expectations. With the shift in my role from observer to participant and co-teacher, I failed to see that my reflective journaling would be influenced and thus altered from objective observations to more emotional entries. I journaled about successes and failures in the lessons, but also about my feelings about the students, the lessons, and the challenges Sarah faced. I should have maintained two journals, one with my feelings about the lessons, and another where I bracketed myself, checked myself for surrounding bias, and objectively journaled about the research study itself. For future researchers, if you are in this dual-role of researcher and participant, having another educational researcher take objective notes during the lessons may provide another route to gain this important information without the threat of bias.

Recommendations for Further Research

This research leaves many questions still to be answered. In this study I looked at the collaborative process of curriculum development in one fixed-library schedule and how it affected the librarian and her second-grade students. How would a similar study compare in an open schedule library where inquiry lessons could be scheduled for longer periods of time as necessary? How might an open schedule also change how collaboration looks when classroom teachers can also be involved in planning and instruction? The inclusion of classroom teachers could, at the very least, inform the participants in the lesson development by providing much-needed information about what is/is not being taught in the classroom and which students are receiving this instruction. In addition, the classroom teacher may provide invaluable information about resources and knowledge about science and science education that could add to the development of the curriculum.

More research is also necessary on the impact of implementing this type of science curriculum on librarian efficacy. While I do not recommend this particular method of developing a novel curriculum from scratch, due to the stress it caused to the librarian, this same curriculum could be implemented in another school to examine the results and feelings of the school librarian when everything is already planned out in terms of time, materials, and other resources needed. Because so much time was spent on the preliminary planning of this research, having this portion completed ahead of time may significantly decrease the stress due to time constraints placed on the school librarian. This may provide an opportunity to see how these types of lessons impact the self-efficacy of the librarian when the stress of development is removed. In future research endeavors, I would recommend keeping planning times to a specific set time and limit the sessions per week (for example one hour of planning once a week) in an effort to reduce the stress of long meetings and impediment on other planning times. Future researchers are encouraged to gain substantial knowledge of the working disciplinary system within the school library prior to the implementation of any new curriculum and to make every effort to adhere to it. It is also encouraged that future researchers plan for extra time during each lesson for redirecting students in the appropriate disciplinary manner, with the advanced knowledge that this may cause loss of time or data.

In this research study I utilized three measures to evaluate the change in student mean scores of a small, second-grade student sample. More research is needed to determine if the results found in this research study would also apply to larger populations and other ages of students. Further analysis of the drawings collected in the DAST pretest and posttests, as well as an addition of reflective questions with the students, may provide more insight into how the drawings did/did not change over time and specifically how they differed by gender. Changes in the structure of the YCVS interviews may also be an area of interest. If time allows, individual student interviews may show a more accurate degree of student change in knowledge, as well as preventing “piggybacking” and thus removing that as a possible confound. Additionally, an examination of student science journals may provide insight into the students’ process during the inquiry cycle, and awareness into the ways the lessons do or do not meet specific science and library standards.

Finally, while I examined the effects of this research on the students and the school librarian, there are possible effects it had on the school at large, which were not measured. Interviews with the teachers, the administration, and other staff may prove insightful to the ways that each group views the importance of the library and the role of the school librarian. Additionally, by having the science materials present in a central space like the library, we may have exposed teachers and students to science materials and activities which they were not aware of before. By conducting interviews with additional members of the school, more insight may be gained into the ways the librarian is viewed, and the effects the library has on the school both directly and indirectly.

Concluding Remarks

Both science instruction and library instruction are marginalized in the elementary school setting, however, in this research study I presented a mutually beneficial way to provide students with library information and science inquiry lessons. I presented the effects that the creation and implementation of the Science in the School Library Inquiry Model (SSLIM) curriculum, a learner-centered, information and science inquiry curriculum, had on the school librarian and her students. And while this research proved stressful for the school librarian, the results from the student measures indicated that students showed statistically significant growth in all science measures used. While it was labor-intense, and in this current format may not be practical for regular instruction, it also showed that this type of experiential inquiry instruction could be successfully carried out in the school library. Additionally, lessons were scheduled within constraints of the fixed library instructional time, but were carried out in a flexible, constructivist environment. In conclusion, with supports such as a co-teacher and/or mentor, and an established curriculum, a school librarian can support both the library and the science curricula through inquiry instruction. Additionally, the school library is a viable educational space within the school where both informational and experiential inquiry cycles can be successfully conducted in the same space and time. Finally, these inquiry lessons can successfully be implemented in a way that allows young students to learn concrete objectives, in a flexible constructivist environment, at their own pace, and driven by their own interests.

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APPENDIX A

Parental Consent Form

[Date of issue]

Dear Parents,

I am conducting a study involving students' thoughts and ideas about science, as well as different ways of teaching science. To conduct this study I need the participation of children in second grade. All materials and instruction used in this study directly align with the Virginia SOLs in science. The attached "Permission for Child's Participation" form describes the study and asks your permission for your child to participate. Student participation is entirely voluntary and all students will remain anonymous.

Please carefully read the attached "Permission for Child's Participation" form. It provides important information for you and your child. If you have any questions pertaining to the attached form or to the research study, please feel free to contact Bree Ruzzi at the number below.

After reviewing the attached information, please return a signed copy of the "Permission for Child's Participation" form to your child's teacher if you are willing to allow your child to participate in the study. Keep the additional copy of the form for your records. Even when you give consent, your child will be able to participate only if he/she is willing to do so.

I thank you in advance for taking the time to consider your child's participation in this study.

Sincerely,

Bree Ruzzi
Darden College of Education
Old Dominion University
Norfolk, VA 23529
Blave001@odu.edu
757-816-3513

PERMISSION FOR CHILD'S PARTICIPATION DOCUMENT

The purposes of this form are to provide information that may affect decisions regarding your child's participation and to record the consent of those who are willing for their child to participate in this study.

TITLE OF RESEARCH:	Inquiry Science in the Elementary School Library: A Case Study of Student and Librarian Perceptions
RESEARCHERS:	Bree Ruzzi, Old Dominion University

DESCRIPTION OF RESEARCH STUDY: This study will be looking at student growth in science concepts and perceptions during library instructional lessons. If you decide to allow your child to participate in this study, your child may be interviewed in a group about their thoughts on science and scientists. These group interviews will be conducted during library time and will not interfere with instructional time. In addition, student science journals will be monitored for changes in science comprehension. All student information will be kept confidential and student names will be de-identified and assigned numbers and/or pseudonyms.

EXCLUSIONARY CRITERIA: In order for your child to participate in this study, your child must be in second grade.

RISKS: There are no risks associated with this study.

BENEFITS: Students in this study may be given the opportunity to discuss their views on science in small group interviews. A summary of results will be made available to both teachers and parents.

COSTS AND PAYMENTS: There is no cost or payment to participate in this research. Students who return signed consent forms, either accepting or denying participation, will receive "Yate's Mate's" dollars for use at the school store. Again, all signed forms even those not choosing not to participate in the study will receive this incentive.

NEW INFORMATION: You will be contacted if new information is discovered that would reasonably change your decision about your child's participation in this study

CONFIDENTIALITY: Participants will be assigned a code number or pseudonym so that your child's name will not be attached to his or her responses. Only researchers involved in the study or in a professional review of the study will have access to data sheets. All data and participant information will be kept in a locked and secure location.

WITHDRAWAL PRIVILEGE: Your child's participation in this study is completely voluntary. It is alright to refuse your child's participation. Even if you agree now, you may withdraw your child from the study at any time. In addition, your child will be given a chance to withdraw at any time if he/she so chooses.

COMPENSATION FOR ILLNESS AND INJURY: Agreeing to your child's participation does not waive any of your legal rights. However, in the event of harm arising from this study, neither Old Dominion University nor the researchers are able to give you any money, insurance coverage, free medical care, or any other compensation. In the event that your child suffers harm as a result of participation in this research project, you may contact Dr. Sue Kimmel at (757) 683-3283 or Dr. David Swain, Chair of the Institutional Review Board at (757) 683-6028.

VOLUNTARY CONSENT: By signing this form, you are saying 1) that you have read this form or have had it read to you, and 2) that you are satisfied you understand this form, the research study, and its risks and benefits. The researchers will be happy to answer any questions you have about the research. If you have any questions, please feel free to contact Bree Ruzzi at (757) 816-3513.

If at any time you feel pressured to allow your child to participate, or if you have any questions about your rights or this form, please call Dr. David Swain, Chair of the Institutional Review Board Chair (757-683-6028) or the Old Dominion University Office of Research (757-683-3460).

3. Please select your child's participation status. Please keep one copy of this form for your records.

☐ **Yes. My child MAY participate in this study.** ☐ **No. My child MAY NOT participate in this study**

Your child's name (please print): ______________________________

Your name (please print): ______________________________

Relationship to child (please check one):
Parent: _____
Guardian: _____

Your Signature: ______________________________

Date: ______________________________

INVESTIGATOR'S STATEMENT: I certify that this form includes all information concerning the study relevant to the protection of the rights of the participants, including the nature and purpose of this research, benefits, risks, costs, and any experimental procedures.

I have described the rights and protections afforded to human research participants and have done nothing to pressure, coerce, or falsely entice the parent to allowing this child to participate. I am available to answer the parent's questions and have encouraged him/her to ask additional questions at any time during the course of the study.

Experimenter's Signature: ______________________________

Date: ______________________________

APPENDIX B

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.

SA = Strongly Agree
A = Agree
UN = Uncertain
D = Disagree
SD = Strongly Disagree

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

APPENDIX C

Draw-A-Scientist Checklist

Each item on the checklist represents one stereotypical image characteristic. The items on the checklist have been derived from reviews of literature, primarily the work of Chambers (1983) and Mead and Metraux (1957). The 'upper" checklist items (items 31-7) relate specifically to those characteristics discussed by Chambers (1983) and others' work and/or items representing stereotypes that have emerged (in science education literature, at least) as concerns over the past few years. Item # 16 is an open-ended item provided for specific details not indicated in items #1-15, such as type of scientist (chemist, biologist, etc.), facial expressions, hair styles, etc.

1. Use one checklist sheet per subject drawing.
2. Place a maximum of only one mark per blank on the checklist
3. If multiple images are present in the drawing (such as two or more scientific instruments) count the drawing as having ONE, NOT TWO.
4. If multiple images of persons appear, such as a group of scientists, mark for any and all stereotypical images that are present. (Note: If one member of the group is male and one is female, record a mark in "male gender" blank but note the presence of the female in item #16.
5. For item #4, the subcategorical items are for more detailed analysis of the images and do not in and of themselves represent stereotypical images. The same applies to subcategory items #4b and #6a.
6. Any relevant captions (item #7) should be written down in item #16 if room doesn't allow under item #7 itself.
7. TOTALS:
    - A. Add the number of marks for the upper checklist and record in the box at the checklist's lower left corner. REMEMBER add ONLY ONE mark per blank.
    - B. Add the number of marks for the lower checklist and record in the box at the checklist's lower left corner. REMEMBER add ONLY ONE mark per blank.
    - C. Add the upper and lower checklist scores for the TOTAL SCORE, and record on the blank at the bottom right corner.
8. ANALYSIS:
    - A. You may select to use the TOTAL SCORE for analysis purposes or you may select to use only the upper (or lower) checklist scores. Use of TOTAL SCORE provides for more variance than the use of only half scores.
    - B. The checklist has been used in a pretest-posttest format with ANCOVA procedures. Other analytical procedures will likely work as well.
    - C. Report other data (such as those in item #16) as percentages of drawings processing specific images.

Draw-A-Scientist Test

RATER: ____________ STUDENT NAME:______________________________

ASSESSMENT 1 2 3

DRAW-A-SCIENTIST CHECKLIST

1. Lab Coat (usually but not necessarily white)……………………………………..________

2. Eyeglasses…………………………………………………………………………________

3. Facial Growth of Hair (beards, mustaches, abnormally long sideburns)…………________

4. Symbols of Research (science instruments, lab equipment of any kind)……..…..________

5. Symbols of Knowledge (principally books, filing cabinets, clipboards,

   pens in pockets, etc.)………………………………………………….……….________

6. Technology (the "products of science)…………………………………………..….________
   a. Types of Technology (tv, phone, missiles, computers, etc.)

7. Relevant Captions (formulae, taxonomic classification, the "eureka syndrome)..________

ALTERNATIVE IMAGES:

8. Male Gender……………………………………...………………………………________

9. Caucasian……………….……………….………………………………………________

10. Indications of Danger……………………………………………………….………..________

11. Presence of Light Bulbs…………………….…………………….……………..________

12. Mythic Stereotypes (Frankenstein creatures, Jekyll/Hyde figures, "Mad/Crazed")________

13. Indications of Secrecy (signs or warnings of "Private," "Keep Out,"
    "Do Not Enter," "Go Away," "Top Secret," etc.)………………………………________

14. Scientists Doing Work Indoors…………………………………………………….________

15. Middle Aged or Elderly Scientist…………………………………………………________

NOTE: Several indicators in the same type in a single drawing count as ONE indicator (eg. Two scientists each with eyeglasses counts as one, not two).

16. Open Comments (dress items, neckties/necklaces, hair style/grooming, smile or frown, stoic expression, bubbling liquids, smoke/steam, type of scientist – chemist, physicist, etc., - etc.)

UPPER/LOWER SCORE: TOTAL SCORE: ______________

APPENDIX D

Science Inquiry Content Pretest

Your Name:____________________________________ Teacher:____________________

Circle the best answer

1) Scientists
    a. Ask questions
    b. Investigate
    c. Draw conclusions
    d. Share findings
    e. All of the above
2) Scientists are
    a. Men
    b. Women
    c. People with different backgrounds
    d. People with different abilities
    e. All of the above
3) What would be the best tool to measure seed growth?
    a. A magnifying glass
    b. A test tube
    c. A ruler
    d. A thermometer
    e. All of the above
4) Scientists conduct investigations in:
    a. Oceans
    b. Gardens
    c. Forests
    d. Laboratories
    e. All of the above
5) What does a botanist study?
    a. The stars
    b. Chemicals
    c. People
    d. Plants
    e. All of the above
6) Which items would be attracted to a magnet?
    a. Plastic
    b. Wood
    c. The same pole of another magnet
    d. The opposite pole of another magnet
    e. All of the above
7) Marine biologists study
    a. Plants
    b. Ocean

- c. Rocks
- d. Outer space
- e. All of the above

8) Which is an example of environmentalism (saving the environment)
   - a. Cleaning your room
   - b. Planting a tree
   - c. Driving to the store
   - d. Calling your friend
   - e. All of the above

9) What is the purpose of drawing in science?
   - a. To use all the colors
   - b. To record what you see
   - c. To make a pretty picture
   - d. To make your teacher happy
   - e. All of the above

10) George Washington Carver was a scientist who
   - a. Was a botanist
   - b. Experimented with peanuts
   - c. Experimented with sweet potatoes
   - d. Discovered crop rotation
   - e. All of the above

11) Scientific Inquiry is
   - a. Asking a questions and investigating to answer it
   - b. Asking a questions and guessing at the answer
   - c. Something done only in science laboratories
   - d. Something that only scientists do
   - e. All of the above

APPENDIX E

Science Inquiry Content Posttest

Your Name:____ Teacher:____________________

Circle the best answer

1) Scientists
   a. Ask questions
   b. Investigate
   c. Draw conclusions
   d. Share findings
   e. All of the above
2) Scientists are
   a. Men
   b. Women
   c. People with different backgrounds
   d. People with different abilities
   e. All of the above
3) What would be the best tool to measure seed growth?
   a. A magnifying glass
   b. A test tube
   c. A ruler
   d. A thermometer
   e. All of the above
4) Scientists conduct investigations in:
   a. Oceans
   b. Gardens
   c. Forests
   d. Laboratories
   e. All of the above
5) What does a botanist study?
   a. The stars
   b. Chemicals
   c. People
   d. Plants
   e. All of the above
6) Marine biologists study
   a. Plants
   b. Ocean
   c. Rocks
   d. Outer space
   e. All of the above
7) Which is an example of environmentalism (saving the environment)
   a. Cleaning your room
   b. Planting a tree

- c. Driving to the store
- d. Calling your friend
- e. All of the above

8) What is the purpose of drawing in science?
- a. To use all the colors
- b. To record what you see
- c. To make a pretty picture
- d. To make your teacher happy
- e. All of the above

9) George Washington Carver was a scientist who
- a. Was a botanist
- b. Experimented with peanuts
- c. Experimented with sweet potatoes
- d. Discovered crop rotation
- e. All of the above

10) Scientific Inquiry is
- a. Asking a questions and investigating to answer it
- b. Asking a questions and guessing at the answer
- c. Something done only in science laboratories
- d. Something that only scientists do
- e. All of the above

APPENDIX F

Young Children's Views of Science Questionnaire

Young Children's Views of Science

Name: ________________________________

Grade Level: _____________

Date: ___________________

Instructions for a teacher / a researcher

- This questionnaire is designed for students who have limited reading and writing abilities.

- It is best to interview a small number of students (3-4) at a time. It is also recommended that the interviews take place during two meeting periods of 30-45 minutes each.

- Please record students' responses to each question with notes and audio-taping.

- Remind the students that there are no "right" or "wrong" answers to the following questions.

PART I.

[This first set of questions is used to establish that the child has some knowledge of what Science is as opposed to other disciplines so that when their opinions are asked during the rest of the interview the interviewer has faith that the child is referring to science. They also serve to establish a conversational rapport with the students. Disregard the rest of a child's responses if it becomes clear that the child's opinions are about something they clearly have no knowledge about. If you are conducting these interviews over a two-day period then you can choose to not involve these students in the second part]

Can you tell me something you know about science?

Do you ever learn about science in school?

Can you tell me what you learned?

Have you ever learned about science somewhere else other than school? Where? What did you do?

How is science different from other things you learn about?

You have been telling me many things about science.
So, "What is Science?"

What is a Scientist?

What do they **Do**?

How do they do their work?

Have you ever seen a scientist?

Do you know one?

What do they do?

PART II.

1. Tell the students that you are going to show them something and that you want them to watch very carefully. Drop the two different size paper helicopters one at a time (see attachment).

   Ask each child to make one observation and then one inference about what they just saw.

   Then ask: Was what you just watched a scientific investigation? Why? Why not?

   If they say it wasn't, ask them what they would need to do to make it into an investigation.

2. There was a woman who loved birds. She traveled around the world to study them. As she traveled she noticed that birds had many differently shaped beaks. For example, some were long and thin, some were big and sharp, and some were tiny and short. She also observed that birds ate different types of food.

   She asked the question, "Is there a connection between birds' beak shapes and the types of food they ate?"

   (a) Do you think she was working like a scientist? Why or why not?
   (b) Do you think her work was an experiment? Why or why not?
   (c)What should she do next to answer her question?

3. How many of you know something about Dinosaurs? (Students will immediately start telling you everything they know about Dinosaurs…you can get some control of the discussion by saying: Each of you tell me **one** thing you know about dinosaurs….then go on to ask the following questions)

   (a) How do scientists know that dinosaurs really lived since there are no dinosaurs around anymore and no one has ever seen them?

   (b) What do scientists think dinosaurs looked like?
   Why do scientists think they look this way?

   (c) Scientists don't always agree on the reasons about what happened to make the dinosaurs all die away. Why do you think they don't agree?

   (d) If your friend said that he knew the reason for what happened to the dinosaurs, what would he have to do to make scientists believe him?
   Why?

[Alternative Question: If the students are too distracted by the dinosaur question then you might choose to use this one instead:]

How do the people who predict the weather on TV use science?

How do they decide what the weather will be today?

Weather reporters don't always agree with each about the weather? Why do you think they disagree?

4. You have all told me know about a lot of different facts and ideas about science.

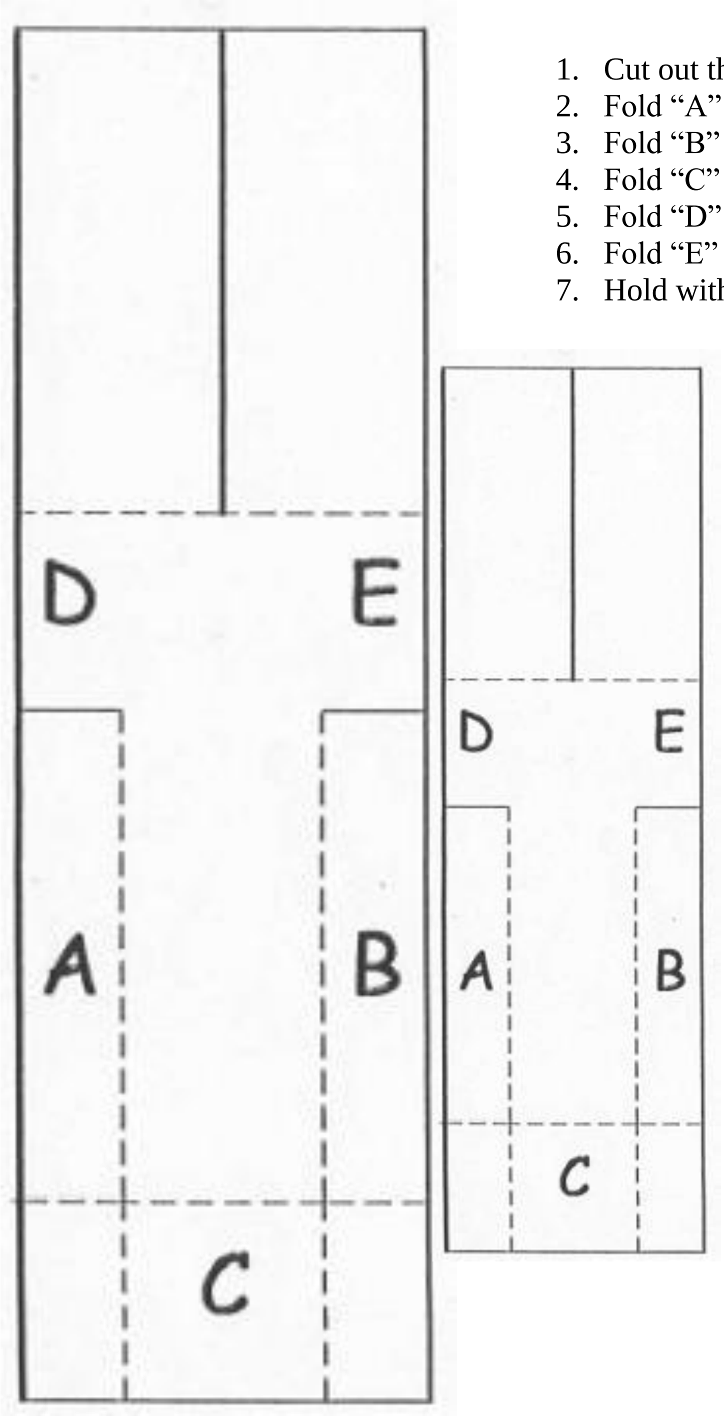
   (a) Do you think scientists will change their minds about these same science facts years from now? Why?
   (b) Can you give me an example of some science idea that might change in the future?

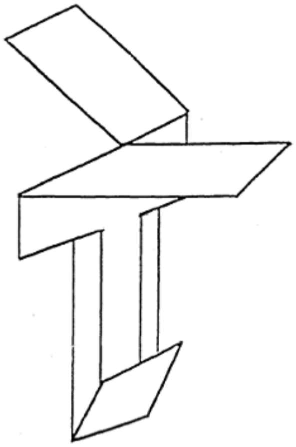
5. Do you think that scientists are creative when they do their work? Can you give me an example?

   When do you think they are creative when they are doing an investigation?

Directions for Paper Helicopters Used with Question #1

1. Cut out the pattern, cutting along all solid line.
2. Fold “A” inward.
3. Fold “B” inward.
4. Fold “C” upward
5. Fold “D” backward.
6. Fold “E” forward.
7. Hold with flaps up and drop from a high place.





Finished Twirly

Young Children's Views of Science Scoring Guide

Overview of Assessed Aspects of NOS and Scientific Inquiry
Tentativeness (NOS)
All scientific knowledge is subject to change.
Scientific knowledge is never absolute or certain. This knowledge is tentative and subject to change as a result of new observations and with the reinterpretation of existing observations Scientific claims change as new evidence, made possible through advances in *theory* and technology, is brought to bear on existing theories or laws, or as old evidence is reinterpreted in the light of new theoretical advances or shifts in the directions of established research programs
Subjectivity (NOS)
Scientific knowledge is partly a function of individuals' backgrounds, beliefs, preferences, knowledge.
Scientific knowledge is subjective. Scientists' beliefs, previous knowledge, training, experiences, and expectations actually influence their work. The development of questions, investigations and interpretations of data are filtered through the human minds of scientists. Subjectivity is apparent in the creativity scientists employ in designing investigations to answer their questions as well as in the organization and analysis of data.
Observations vs. Inferences (NOS)
All scientific knowledge is composed partly of observation and partly of inference.
Observations are gathered through human senses or extensions of the senses. Inferences are interpretations of those observations.
Empirical Basis of Science (NOS)
Scientific knowledge is at least partially developed from reference to the empirical world.
Scientific knowledge is, at least partially, based on and/or derived from observations of the natural world.
All investigations begin with a Question (SI)
Scientific investigations involve asking questions, answering a question and comparing the answer with what scientists already know about the world.
Scientists Collect Empirical Data to Answer their Questions (SI)
Science distinguishes itself form other ways of knowing through the use of empirical evidence as a basis for explanations about how the world works. Scientists concentrate on getting accurate data form observations of phenomena.
Data and Prior knowledge are used to Answer Questions (SI)
Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).
There is No Single Scientific Method (SI)
No single set or sequence of steps characterizes all scientific investigations. In addition to classic Experimental design, Descriptive and Correlational investigations are also valid

methods to develop scientific knowledge. Scientists use different kinds of investigations depending on the questions they are trying to answer.

Scoring Summary Chart

	Questions							
	Part I		Part II					
Aspects of NOS and SI addressed:	A	B	1	2	3a,b	3c,d	4	5
Tentativeness (NOS)					✓	✓	✓	✓
Subjectivity (NOS)		✓			✓		✓	✓
Observation vs. Inference (NOS)			✓	✓	✓			✓
Empirically-based (NOS)	✓			✓	✓	✓		
Begin with a question (SI)		✓	✓	✓				✓
Collecting data to answer (SI)	✓	✓	✓	✓	✓			
Using data and prior knowledge (SI)		✓		✓	✓	✓		
No single scientific method (SI)	✓	✓	✓	✓				

Categories of Understanding for Aspects of NOS and SI

Students' views of Scientific Inquiry and Nature of Science aspects are categorized into naïve or informed based on the following criteria:

Naïve:	**Informed:**

Student's response is not consistent with any part of NOS or SI aspect.	Student's response is consistent and addresses most parts of NOS or SI aspect.

Detailed Explanation and Sample Responses

EACH QUESTION ON THE FOLLOWING PAGES IS FOLLOWED BY A DESCRIPTION OF WHAT IS BEING ASSESSED AND WHAT IS CONSIDERD TO BE AN ANSWER CONSISTENT WITH REFORM DOCUMENTS AND CONTEMPORARY VIEWS ABOUT SCIENCE. “SCORING” OF ANSWERS IS NOT MEANT TO YIELD A NUMERICAL VALUE, BUT RATHER A DESCRIPTION OF WHETHER THE RESPONDENT HAS A “NAÏVE” OR DESIRED “INFORMED” VIEW.

Young Children’s Views of Science

Name: ________________________________
Grade Level and /or Age: _________________
Date: _________________________________

Instructions for a teacher / a researcher:

- This questionnaire is designed for students who have limited reading and writing abilities.
- It is best to interview a small number of students (3-4) at a time. It is also recommended that the interviews take place during two meeting periods of 30-45 minutes each.
- Please record students’ responses to each question with notes and audio-taping.
- Remind the students that there are no “right” or “wrong” answers to the following questions.

PART I.

Can you tell me something you know about science?

Do you ever learn about science in school?

Can you tell me what you learned?

Have you ever learned about science somewhere else other than school? Where? What did you do?

How is science different from other things you learn about?

This first set of questions is used to establish that the child has some knowledge of what Science is as opposed to other disciplines. Therefore, when their opinions are asked during the rest of the interview, the interviewer has faith that the child is referring to Science. They also serve to establish a conversational rapport with the students. Disregard the rest of a child's responses if it becomes clear at this point that the child's answers show they clearly have no knowledge of Science. If you are conducting these interviews over a two-day period you can choose to not involve these students in the second part.

A. You have been telling me many things about science. So, "What is Science?"

Complete responses should include references to both a body of knowledge (life, physical, earth and space content, etc.) and methods and process (observing, experimenting, measuring, etc.) for the development of the knowledge. Students' responses often include the science content they are currently studying or happen to be interested in.

An informed response should refer to reliance on data from the natural world (empirical basis), and systematic or organized approach to collection of data. An example of an informed answer is, "In science you just don't say something, you collect data and have to think about it and have to figure it out."

It is common for students to focus only on the specific subject matter that is being studied at the time or objects about science that are on view in the classroom. They might also refer to something they have seen on television or at an informal site such as a zoo or museum especially if they had recently visited one of these places.

Students are likely to naively state that science is only about mixing, experimenting and blowing things up. That is it follows a single method (the scientific method).

Students will most likely not refer to anything related to epistemology or characteristics of the knowledge that results from the processes. Rarely do young children refer to science as a "way of knowing" nor is this expected at this age.

B. What is a Scientist?

What do they **Do**?
How do they do their work?
Have you ever seen a scientist?
Do you know one? What do they do?

This set of questions targets views of what scientists do when they "do science" and focus on students' understanding of Scientific Inquiry. Typical responses describe activities that might include investigate, experiment, ask questions, make observations, collect and analyze data, and use what they know and found out come to conclusions. Informed answers also address scientists "thinking" about things they observe and coming up with "new ideas" and "inventions."

Naïve responses that are too general include mixing up chemicals, blowing things up, or making potions.

Follow up should probe for more specific examples of what other types of investigations scientists (i.e., non-experiments like wolves in the wild) can do and how scientists go about finding answers.

PART II.

1. Tell the students that you are going to show them something and that you want them to watch very carefully. Drop the two different size paper helicopters one at a time (see attachment).

   Ask each child to make one observation and then one inference about what they just saw.

   Then ask: Was what you just watched a scientific investigation? Why? Why not?

   If they say it wasn't, ask them what they would need to do to make it into an investigation.

Students should be able to identify and distinguish between observations and inferences. Some examples of students' observations include "the smaller one hit the ground first" or the smaller one "twirled faster than the larger one." Inferences made include "the air kept the larger one up" and "the air made them twirl" or that the bigger one is "too heavy to spin fast."

Students with informed views will recognize that this is not an investigation since this activity was not driven by a question. Students with naïve views will identify any hands–on activity or fun observation as an investigation. Student responses with informed views might include that a question is needed to begin an investigation and that they would need to collect date, make observations and try to answer their question with this new data and what they already observed about the paper helicopters.

2. There was a woman who loved birds. She traveled around the world to study them. As she traveled she noticed that birds had many differently shaped beaks. For example, some were long and thin, some were big and sharp, and some were tiny and short. She also observed that birds ate different types of food.

    She asked the question "Is there a connection between birds' beak shapes and the types of food they ate?"

    (a) Do you think she was working like a scientist? Why or why not?
    (b) Do you think her work was an experiment? Why or why not?
    (c) What should she do next to answer her question?

Students should recognize that she was acting scientifically because she was making observations and inferences and collecting and analyzing data to help answer her question. Since all investigations begin with a question, her work was scientific because it was guided by her question.

This question examines students' views of an experiment as being a general scientific activity or a specific scientific procedure. Experiment in science is that procedure that involves identification and manipulation of variables and use of controls. Experiments seek cause/effect relationships by changing only one variable in the system and measuring/observing the effect of that change. This example of beak shape and food selection is not an experiment; rather it is a Correlational investigation. There is no manipulation of the beak or food source. The correlation between the beak shape and food source is found through repeated observation, not experimentation. Young children probably won't use this term but may say instead that there are "lots of ways scientists do their work…sometimes they just look at things for a long time to get answers to their questions."

Students with naive views of investigations will describe this activity as experimental because observations and conclusions were made or may not consider this work scientific at all because it was not an experiment.

To support this scientist's hypothesis, students' suggestions should include situations that will add more empirical data to analyze such as traveling to other locations, comparing more birds or feeding them different types of foods. Students may mention making more observations and inferences, and adding this new information to what the scientist already knew to answer her question.

3. How many of you know something about Dinosaurs?

    (a) How do scientists know that dinosaurs really lived since there are no dinosaurs around anymore and no one has ever seen them?

    (b) What do scientists think dinosaurs looked like? Why do scientists think they look this way?

These questions focus on the roles of observation and inference in science and that they use the data and what they know to answer questions. Informed answers would include that scientists have some data, made observations and have inferred from this data what dinosaurs looked like.
Informed answers include students talking about how scientists "use their brains to think more about what they observe" and that "they found these big bones and figures it had to come from a great big animal."

Answers to 3a and 3b may also allow you to determine whether a student understands that the development of scientific knowledge (via inferences) involves scientists collecting data to answer their questions. Young children may naively say that the scientists saw pictures of the dinosaurs in books or on television so that is how they know what they look like. An example of a more informed answer is that "the scientists observed dinosaur bones or fossils and then tried to put them together like other animals they could see….if they saw different animals then they put them together like them."

    (c) Scientists don't always agree on the reasons about what happened to make the dinosaurs all die away. Why do you think they don't agree?

This question reflects students' views about the subjective and tentative nature of science. The informed response would reflect some understanding that different scientists bring different backgrounds, experiences and ideas to the interpretation of data. An informed answer might be, "they are all different and know different stuff and don't have the same brains" or that "they don't have to agree, maybe they just look at the bones and think different about them and put them together in different ways." Naïve responses include statements such as "they don't like each other" or "somebody is right and tells the other scientists they are wrong and they get mad at each other" or "they don't have to agree if they are friends."

It is important to discern whether the student understands that different interpretations do not necessarily mean that someone is right and someone is wrong. This is a difficult idea for young students.

    (d) If your friend said that he knew the reason for what happened to the dinosaurs, what would he have to do to make scientists believe him? Why?

The informed answers should reflect students' understanding of the empirical nature of science, that scientists collect data to answer their questions and that data and prior

knowledge are used to answer their questions. Examples of informed answers include, "he would have to find more bones or the whole thing and show them" and "she would need to show them that her idea was better than theirs because it made more sense than theirs because she had more proof". Naïve answers include "I'd tell him to go on television and tell them on the news" or "interview a caveman" or "no one will believe a little kid."

4. You have all told me know about a lot of different facts and ideas about science.

    Do you think scientists will change their minds about these same science facts years from now? Why?

    Can you give me an example of some science idea that might change in the future?

This question focuses on the idea that all scientific knowledge is tentative or subject to change. So, you are looking for the students to agree that the knowledge will possibly change. Naïve answers involve students saying that "scientists are smart and they are always right" or "some things about science change like the weather everyday but the sun and moon won't change."

On a superficial level, most students will recognize that knowledge changes because we now know more due to additional experiments/investigations, new evidence or the availability of new technology. A more in-depth, but not common, answer would include the idea that knowledge changes because scientists view the same data in a different way than before.

Students' examples of science knowledge include finding new ways to help other people, finding cures for diseases such as cancer, finding alien life on other planets or new technologies including new types of televisions or being able to time travel.

5. Do you think that scientists are creative when they do their work?
    Can you give me an example?
    When do you think they are creative when they are doing an investigation?

The desired answer here is "yes" and most students will answer this way. However, students' responses to the other parts of this question will give you more information about the adequacy of students' beliefs.

This question gives students another opportunity to talk about what they think scientists do and how they work. Students with informed views will talk about how scientists "ask questions and think about the things they observe or the data they collect and try to answer their questions or find new stuff out." Naïve responses will include notions of "mad scientists" blowing things up and making potions.

Most students will only understand, or at least say, that scientists use their creativity and imagination in the planning of investigations. Few students in these grades will tell you that scientists use creativity and imagination during an experiment/investigation and in the

interpretation of data and reporting of results. However, informed students will say that “scientists observe and think about things and have their own ideas about things.”

This question relates back to students’ understanding of how creativity, subjectivity, and inference permeate all of science.

APPENDIX G

Abbreviated Young Children's Views of Science

Directions: Tell the students you are going to ask them some questions about science. Explain that there are no "right" or "wrong" answers, you just want to know what they think.

1. Can you tell me something you know about science?

2. Do you ever learn about science in school?

   If yes: Can you tell me what you learned?
   If no: Have you ever learned about science somewhere else other than school? Where? What did
   you do?

3. Tell the students that you are going to show them something and that you want them to watch very carefully. Drop the two different size paper helicopters one at a time (see attachment).

   Ask each child to make one observation and then one inference about what they just saw.

   Then ask: Was what you just watched a scientific investigation? Why? Why not?

4. There was a woman who loved birds. She traveled around the world to study them. As she traveled she noticed that birds had many differently shaped beaks. For example, some were long and thin, some were big and sharp, and some were tiny and short. She also observed that birds ate different types of food.

   She asked the question, "Is there a connection between birds' beak shapes and the types of food they ate?"

   (a) Do you think she was working like a scientist? Why or why not?
   (b) Do you think her work was an experiment? Why or why not?
   (c)What should she do next to answer her question?

5. How do the people who predict the weather on TV use science? How do they decide what the weather will be today? Weather reporters don't always agree with each about the weather? Why do you think they disagree?

APPENDIX H

Student Assent

My name is Bree Ruzzi. I work at Old Dominion University.

I am asking you to take part in a research study because I am trying to learn more about what you think about science and scientists.

If you would like to participate, you will be asked some questions. You will be asked about science, how you think it works, and who does science. Answering these questions will take about 20 minutes.

You do not have to be in this study. No one will be mad at you if you decide not to do this study. Even if you start, you can stop later if you want. You may ask questions about the study.

If you decide to be in the study I will not tell anyone else what you say or do in the study. Even if your parents or teachers ask, I will not tell them about what you say or do in the study.

Signing here means that you have read this form or have had it read to you and that you are willing to be in this study.

Signature of subject____

Subject’s printed name ____

Signature of investigator____

Date____________________________

APPENDIX I

INFORMED CONSENT DOCUMENT

OLD DOMINION UNIVERSITY

PROJECT TITLE: Inquiry Science in the Elementary School Library: A Case Study of Student and Librarian Perceptions (Librarian Perceptions)

INTRODUCTION

The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participation in this research, and to record the consent of those who say YES. The research study *Inquiry Science in the Elementary School Library: A Case Study of Student and Librarian Perceptions (Librarian Perceptions)* will be conducted primarily in the school library of Yates Elementary School, Newport News, Virginia.

RESEARCHERS

Responsible Principal Investigator:

Sue Kimmel, PhD

Graduate Program Director of School Library Science

Graduate Program Director of Graduate Studies

Darden College of Education

Curriculum and Instruction

Investigator:

Bree Ruzzi, Doctoral Candidate

Darden College of Education

Curriculum and Instruction

DESCRIPTION OF RESEARCH STUDY

Few studies have been conducted looking into the subject of school librarians in fixed library schedules. None of them have examined the process of a school librarian in a fixed library schedule implementing an inquiry-based science curriculum during library lessons. This study seeks to observe the processes of an elementary school librarian as she implements a novel science curriculum into her library lessons

If you decide to participate, then you will join a study involving lesson planning and implementation, interviews, three short surveys, and a personal journal on your feelings and the process. If you say YES, then your participation will last for approximately eight to ten weeks total over the 2016-2017 school year at Yates Elementary School Library. You will be the only school librarian participating in this study.

EXCLUSIONARY CRITERIA

There is no exclusionary criteria, however you should have completed the Science Efficacy Belief Instrument (STEBI-B), the Views of Nature of Science (VNOS-D) and the Views of Scientific Inquiry (VOSI) to the best of your knowledge prior to beginning the lesson development.

RISKS AND BENEFITS

RISKS: There are no inherent risks associated with this research study.

BENEFITS: The main benefit to you for participating in this study is to gain experience in implementing inquiry-based science lessons in the library. In addition, any additional supplies deemed necessary for the development and completion of the science lessons will be purchased by the researcher and donated to the school library upon conclusion of the research study. This may include but is not limited to: books, scientific inquiry materials, student journals, etc.

COSTS AND PAYMENTS

The researchers want your decision about participating in this study to be absolutely voluntary. Yet they recognize that your participation may pose some inconvenience and costs when purchasing materials necessary for scientific inquiry. In order to mitigate these costs the researcher will purchase the necessary materials. These materials will be donated to the school library upon completion of the research study.

NEW INFORMATION

If the researchers find new information during this study that would reasonably change your decision about participating, then they will give it to you.

CONFIDENTIALITY

The researchers will take every reasonable measure to keep private information, such as personal information, school information, questionnaires, interviews, journal entries and audio recordings confidential. The researcher will remove identifiers from the information, destroy audio recordings upon transcription, store all information in a password protected computer and/or a locked filing cabinet prior to processing. The results of this study may be used in reports, presentations, and publications; but the researcher will not identify you. Of course, your records may be subpoenaed by court order or inspected by government bodies with oversight authority.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. Your decision will not affect your relationship with Old Dominion University, or otherwise cause a loss of benefits to which you might otherwise be entitled.

COMPENSATION FOR ILLNESS AND INJURY

If you say YES, then your consent in this document does not waive any of your legal rights. However, in the event of harm arising from this study, neither Old Dominion University nor the researchers are able to give you any money, insurance coverage, free medical care, or any other compensation for such injury. In the event that you suffer injury as a result of participation in this research project, you may contact Dr. Sue Kimmel at 757-683-3283 , Bree Ruzzi at 757-816-3513, Dr. Tancy Vandecar-Burdin the current IRB chair at 757-683-3802 at Old Dominion University, or the Old Dominion University Office of Research at 757-683-3460 who will be glad to review the matter with you.

VOLUNTARY CONSENT

By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them:

Dr. Sue Kimmel at 757-683-3283

Bree Ruzzi at 757-816-3513

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair, at 757-683-3802, or the Old Dominion University Office of Research, at 757-683-3460.

And importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher should give you a copy of this form for your records.

Subject's Printed Name & Signature	**Date**
Parent / Legally Authorized Representative's Printed Name & Signature (If applicable)	**Date**

Witness' Printed Name & Signature (if Applicable)	**Date**

INVESTIGATOR’S STATEMENT

I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent form.

Investigator's Printed Name & Signature	**Date**

APPENDIX J

Example List of Supplementary Books by Lesson

Diverse Scientists
Michael Faraday by Mary Salzmann
Rachel Carson: Clearing the Way for Environmental Protection by Mike Venzia
Daniel Hale Williams: Surgeon Who Opened Hearts and Minds by Mike Venzia
Thomas Edison: Inventor with a Lot of Bright Ideas by Mike Venzia
Benjamin Benneker: Pioneering Scientist by Ginger Wadsworth
Luis Alverez: Wild Idea Man by Mike Venzia
A Picture Book of George Washington Carver by David Adler
Albert Einstein: Universal Genius by Mike Venzia
Stephen Hawking: Cosmologist Who Gets a Big Bang Out of the Universe by Mike Venzia
Jane Goodall: Researcher Who Champions Chimps by Mike Venzia
Marie Curie: Scientist Who Made Glowing Discoveries by Mike Venzia
The Fantastic Undersea Life of Jacques Cousteau by Dan Yaccarino
Benjamin Franklin by Martha Rustad

Botany
Why Do Leaves Change Color? By Betsy Maestro
From Seed to Plant by Gail Gibbons
Apples, Apples, Apples by Nancy Wallace
Pumpkin, Pumpkin by Jeanne Titherington
It’s Pumpkin Time by Zoe Hall
The Reason for a Flower by Ruth Heller
Stems by Vijaya Khisty Bodach
Seeds by Vijaya Khisty Bodach
How Do Apples Grow? By Betsy Maestro
Seed, Sprout, Pumpkin, Pie by Jill Esbaum
From Seed to Pumpkin by Wendy Pfeffer
Flowers by Vijaya Khisty Bodach
Fruits by Vijaya Khisty Bodach
Leaves by Vijaya Khisty Bodach
Roots by Vijaya Khisty Bodach
Make me a peanut butter sandwich and a glass of milk by Kevin Robbins
You can use a magnifying glass by Wiley Blevins
You can use a balance by Linda Bullock
How we use plants for shelter by Sally Morgan
Looking through a microscope by Linda Bullock
Scientists ask questions by Ginger Garrett
Seeds by Ken Robbins
Dirt : the scoop on soil by Natalie Myra Rosinsky and Sheree Boyd
Life cycle of a bean by Angela Royston
Oh say can you seed? By Bonnie Worth
The scientific method in the real world by L.E. Carmichael

Journey into the invisible : the world from under the Microscope by Christine Schlitt
Flowers by Vijaya Khisty Bodach
Animal and plant survival by Nicholas Brasch
Single-celled organisms by Elaine Pascoe
Plants are alive! By Molly Aloian
Plant secrets by Emily Goodman
Amazing plants By Honor Head
What is a plant? By Bobbie Walker Kalman
How do plants grow? By Julie Lundgren
Plant life cycles by Julie Lundgren
How are plants helpful? By Kelley Macaulay
How do plants survive? By Kelley Macaulay
Plants with seeds by Elaine Pascoe
Plant classification by Louise Spilsbury
Experiments with plants by Salvatore Tocci
Plant Adaptations by Julie Lundgren
Plants feed me by Lizzy Rockwell
Plants Live Everywhere! By Mary Dodson Wade
Plants Without Seeds by Elaine Pascoe
Soil by Christin Ditchfield
Soil : digging into Earth's vital resource by Darlene Ruth Stille
Seed, Sprout, Pumpkin, Pie by Jill Esbaum
Grow Your Own Soup by John Malam
Plants We Eat by Christine Petersen
One Bean by Anne Rockwell
The life cycle of a bean by Linda Tagliaferro

VITA

Bree Ruzzi, Ph.D.
Adjunct Instructor
STEMPS
Old Dominion University
4301 Hampton Blvd., Norfolk, VA 23529
bruzzi@odu.edu (757) 816-3513

EDUCATION

Doctor of Philosophy: Education, Curriculum and Instruction
Old Dominion University, Norfolk, VA
2019

Master of Science in Education: School Library Science
Old Dominion University, Norfolk, VA
2001

Bachelor of Science: Biology
Radford University, Radford, VA
1996

TEACHING EXPERIENCE

Adjunct Instructor: Information Literacy for the Digital Age

LIBS 110_33996	Summer 2019
LIBS 110_32964	Summer 2019
LIBS 110_26456	Spring 2019
LIBS 110_26458	Spring 2019
LIBS 110_26968	Spring 2019
LIBS 110_15107	Fall 2018
LIBS 110_17238	Fall 2018
LIBS 110_19607	Fall 2018
LIBS 110_27200	Spring 2018
LIBS 110_29568	Spring 2018
LIBS 110_31758	Spring 2018
LIBS 110_15878	Fall 2017
LIBS 110_18554	Fall 2017
LIBS 110_19859	Fall 2017

Graduate Student Teacher Mentorship
Fall 2018
Fall 2017

Graduate Teaching Assistant (Instructor): Information Literacy for the Digital Age

LIBS 110_21247	Fall 2015

LIBS 110_31709 Spring 2016
LIBS 110_35420 Summer 2016

Graduate Research Assistant: to Dr. Jody Howard and the NxtWave Program
2014-2015

School Library Specialist: Kellam High School, Virginia Beach, VA
2008-2014

School Library Specialist: Indian Lakes Elementary School, Virginia Beach, VA
2002-2008

School Library Specialist, Bayview Elementary School, Norfolk, VA
January 2002- August 2002

PUBLICATIONS

Ruzzi, B. (in review). Multimodal science experiences in preschool classrooms: An examination of knowledge building through three instructional models. *Early Childhood Education Journal.*

Ruzzi, B. & Eckhoff, A. (2017). STEM resources and materials for engaging learning experiences. *Young Children, 72*(1).

Kimmel, S., Howard, J. & **Ruzzi, B**. (2016). Educating LIS leaders for radical change through community service. *Journal of Education for Library and Information Science, 57*(2), 174-186.

Trzeciakiewicz, S. & **Ruzzi, B**. (Summer, 2014). VAASL: You've come a long way, baby. *VAASL Voice.*

CONFERENCE SUBMISSIONS (REFEREED PROPOSALS)

Ruzzi, B. (2019). *Three-dimensional science in the school library: Student results and perceptions from a learner-centered science curriculum* [Poster Submission.] American Educational Research Association Annual Meeting, Toronto, Canada.

Trzeciakiewicz, S., Dickinson, G. & **Ruzzi, B.** (2018, January). *Toward a taxonomy of school libraries* [Poster Submission.] Association for Library and Information Science Education Annual Conference, Denver, CO.

Ruzzi, B. (2017, January). *Inquiry science in the elementary school library: A case study of student and librarian perceptions.* [Poster Submission.] Association for Library and Information Science Education Annual Conference, Atlanta, GA.

Ruzzi, B. & Eckhoff, A. (2016, April). *Multimodal science experiences in preschool classrooms:*

An examination of knowledge building through three instructional methods. American Educational Research Association Annual Meeting, Washington DC.

Howard, J., Kimmel, S. & **Ruzzi, B**. (2016, April). *Educating library professionals to be leaders: Community service to engage with a diverse public*. American Educational Research Association Annual Meeting, Washington DC.

Ruzzi, B. (2016, January). *The use of inquiry-based science instruction and award winning literature in the library: Exploring a radical change in library lessons.* Association for Library and Information Science Education Annual Conference, Boston, MA.

Kimmel, S., Howard, J. & **Ruzzi, B**. (2016, January). *Educating leaders for radical change through community service*. Association for Library and Information Science Education Annual Conference, Boston, MA.

GRANTS, AWARDS & RECOGNITIONS

Old Dominion University Fellow: Darden College of Education Dissertation Fellowship
2016-2017

Causality: School Libraries and Student Success (CLASS) Research Summit: American Association of School Librarians, Washington DC
2016

Graduate Research Assistant: Funded by the Institute of Museum and Library Services
2014-2015

NxtWave Scholar Grant Recipient: Funded by the Institute of Museum and Library Services
Old Dominion University
2014-2015

STATE/REGIONAL CONFERENCE PRESENTATIONS

Ruzzi, B. (October, 2017). *Selecting quality children's literature to support science learning.* Early Childhood Symposium, Old Dominion University, Norfolk, VA. [Invited speaker]

Kimmel, S., & **Ruzzi, B.** (October, 2016). *Chart a course the STEM through text sets*. Annual Meeting of the Virginia Association of School Librarians, Norfolk, VA.

Ruzzi, B. & Trzeciakiewicz, S. (March, 2014). *We "genrefied" our fiction section and lived to tell about it.* York Regional Meeting of the Virginia Association of School Librarians, Chesapeake, VA.