TEACHER CANDIDATES' PERCEPTIONS REGARDING THE INTEGRATION OF FICTIONAL LITERATURE INTO ELEMENTARY SCIENCE INSTRUCTION

By

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DEDICATION

This dissertation is dedicated to my husband Brad, without whose love and support completing this dissertation would not have been possible, and my daughter Victoria, who inspires me to be the best person I can be as a positive example for her.

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When I began my doctoral work, I was not fully aware of the journey ahead of me. Through all my coursework, collaborations with professors, dialogue and debates with classmates, and writing (so much writing!), I have grown in ways I did not anticipate when I started this process. I would not have made it to this point without the love, support, and guidance from many sources, who are acknowledged below.

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ABSTRACT

The purpose of this study was to investigate the thoughts, feelings, and beliefs held by teacher candidates (TCs) regarding the integration of fictional literature into elementary science instruction. Data were collected in the forms of a Q sort completed by two sections of TCs as an in-class activity, demographics and background information filled out by each participant, and two focus groups. The data were analyzed through a blend of Q methodology and Yin's five phase analysis approach (2011), and a constructivist framework was used to analyze the potential impact TCs' background had on their perceptions of the use of fictional literature in elementary science. Key findings indicated that while many TCs have limited backgrounds in the use of fictional literature during science and would like more information about how to use it, overall, there was strong support for its use as a science teaching tool because it makes science more approachable, builds excitement, and encourages students to become more engaged.

Key terms: constructivism, fictional literature, Q methodology, science, teacher candidates

I. INTRODUCTION TO THE STUDY

When I was younger I used to think Science was boring, I automatically thought about a textbook because I never got the opportunity to be hands on with it. However, my perception of Science has changed since I entered college. I have become mesmerized by it and cannot wait to teach the subject to my future students. I hope my students become eager to learn the subject not only in their elementary years, but throughout their life. Thinking of all the emotions that this class has brought me through the activities that we've done, I came up with the following: Science is like a birthday present, it brings curiosity, endless possibilities, surprises, and leaves you wanting more.

-Kay S.-V. (undergraduate science methods student)

Prelude

As an undergraduate, I had a difficult time choosing a major. My interests were varied and, though I had always excelled in English, I also had a great interest in biology. Ultimately, I selected biology as my major prior to beginning my freshman year, believing I was destined for a career in pediatrics. Though I stuck with it for two years, my heart wasn't in it. Largely due to my lack of interest in chemistry and physics, I switched my major to English and kept biology as a minor. At the time, the two disciplines seemed disparate with little to connect the two. Though there were some writing pieces we had to do in my biology classes, that was about the only connection to English/Language Arts (ELA), and there were no assignments in my English classes that incorporated the sciences. I took classes in the two subjects, but I neither saw much of a connection between them nor did I know what I would do with the degree once I completed my undergraduate work.

It wasn't until a close friend shared her excitement about becoming a teacher that I began to think about becoming an educator. My passion has always been working with children, and I felt like teaching would be a good way to do something I loved. I did not know at the time just how right I was. I am, and always will be, an educator, and I have been blessed with an exciting career educating others and sharing my love of learning across the disciplines. I worked in public schools for 12 years, in second through eighth grades. I was a science teacher for many of those years and, particularly in elementary school, it was disheartening to see science neglected. For example, when I taught third grade, we were allowed to teach science for 30 minutes at the end of the day twice a week. Though this is the worst situation I encountered, in my experience, teaching science in elementary school was not given nearly as much importance as ELA and math. With the push for interdisciplinary work, I began to seek out ways to blend science with other disciplines, including ELA, since a large portion of instructional time was dedicated to that subject. It wasn't until I became a teacher myself, and had to deal with the realities of the education system and those subjects deemed more important than others, that I began to see the value in combining the content areas.

Last year, I began teaching undergraduate courses at a four-year university while pursuing my Ph.D. in Education - School Improvement at the same institution. Though different than working with elementary and middle schoolers, I continue to enjoy sharing my love of learning with students. My favorite course to teach is Science in Elementary Education. One of the assignments I give requires students to select three books they could use to teach any of the elementary science Texas Essential Knowledge and Skills (TEKS), and provide an explanation for how the books and the TEKS align. Though that is the only parameter for the assignment, the majority of students select non-fiction books, explaining that the books give facts so they are useful to teach the TEKS. Though I am pleased that the students are able to select appropriate literature to connect to the science content, there is an abundance of fictional literature that is equally useful to aid in science instruction, and I wondered why students tend to overlook it. I did not see much connection between science and literature until I had been a practicing teacher for several years, and I wondered if undergraduates are in a similar situation. These wonderings led to my dissertation topic: exploring teacher candidates' (TCs') views on incorporating fictional literature into elementary science instruction.

Positionality

I would be remiss if I did not address my positionality in relation to this topic (Creswell, 2013). In conducting research, especially concerning an issue about which I have a strong viewpoint, it is inevitable that I will incorporate some of my own background and biases into the experience. In an effort to reduce and explain these potential biases, one should acknowledge his/her positionality in relation to the topic and participants in the study (Creswell, 2013). I am a proponent of using fictional literature as a teaching tool in elementary science instruction. I taught elementary science for six years, and middle school science for several more, and fictional literature was an important part of my instruction. Whether reading a story to "hook" the interest of my students, or having students identify the scientific concepts embedded in a storyline, I found fictional literature to be a very useful tool. For example, in a lesson on basic needs, I read *The Ants and the Grasshopper*. In this fable, the ants busily work to gather food and stock their shelter for the upcoming winter while the grasshopper just plays. Come winter time, the ants are happy while the grasshopper is suffering because it is unable to meet its needs. While I was reading the story, the students wrote down ways the ants were addressing their needs and how they contributed to their survival, and then we had a class discussion about it. The students were engaged and it gave me an opportunity to see if students could demonstrate their understanding of science concepts in a new, somewhat real-world context.

Background

Interdisciplinary work is encouraged in K-12 education (Bradbury, 2014; Fleener & Bucher, 2003; Osborne, 2002), so combining content areas is an important skill for prospective teachers to develop. Based on students' own experiences in school, however, they may not have much knowledge about how to do this effectively. In elementary school, a significant portion of the day is set aside for language arts instruction. By incorporating literature into science lessons, teachers may be able to increase the instructional time devoted to science (Ledoux & McHenry, 2004). Language arts and science integrate well together since they share similar cognitive processes (Bradbury, 2014). Reading to acquire information and writing to share information are important skills in language arts, and they are essential to scientists as well. According to Romance and Vitale (2001), blending the two disciplines has the potential to improve both students' science knowledge and reading achievement. Additionally, because "literature written in narrative style provides familiarity for linking personal experiences and feelings with factual information and new concepts" (Fleener & Bucher, 2003, p. 77), fictional literature provides a foundation on which to build and develop students' understanding of science concepts.

Based on the aforementioned research and literature, it is evident that science and literature blend well together. In both, students are active participants in the process of engaging with the content in order to comprehend it (Bradbury, 2014). By using literature to support science concepts, students can "develop more complex understanding as new concepts are assimilated into the current knowledge structures" (Casteel & Isom, 1994, p. 54). Though there are variations in instructional approaches in both language arts and science, "there is a great deal of overlap in the processes through which new knowledge is constructed" (Bradbury, 2014, p. 467). For students to develop full meaning of science concepts, they need more than just doing science in a lab. For them to "gain insights and understanding of the manner and nature of scientific reasoning, [teachers] must offer them opportunity to use and explore that language, i.e. to read science to discuss the meaning of its texts, [and] to argue how ideas are supported by evidence" (Osborne, 2002, p. 204). Being able to read and discuss science content are "higher level thinking practices similar to those used by elementary teachers when they use good literature for reading instruction" (Fleener & Bucher, 2003, p. 76). This is particularly important when using fictional literature to teach science, as students have been exposed to story-form since beginning formal instruction in school. However, there is a lack of emphasis placed on this type of interdisciplinary work in undergraduate methods courses and national publications regarding elementary science instruction, which is a profound oversight.

Although students who recently graduated from a teacher preparation program might be considered new to teaching, they are not new to the profession. Throughout their K-12 schooling, they observed and engaged in a wide variety of teaching practices. Whatever strategies their own teachers used became part of their teaching schemas, and helped shape their understanding of what it means to be a teacher (Bryan, 2003; Dickson & Kadbey, 2014; Eick & Reed, 2002; Skamp & Mueller, 2001). The backgrounds that TCs bring with them to their undergraduate teaching methods courses impact their beliefs about teaching which, in turn, may influence their receptiveness to new concepts and ideas introduced during methods courses. While some research shows these belief systems become entrenched and are difficult to overturn, Skamp and Mueller (2001) found that coursework and practicum experiences take on approximately equal importance to the influence of TCs' own schooling. Additional research exploring the potential for TCs to change their attitudes and beliefs found that effective instruction may help TCs adapt the beliefs they held upon beginning a science methods course (Kazempour, 2014; Ucar, 2012).

Understanding the backgrounds and experiences TCs bring with them to methods courses is extremely important for instructors in a teacher preparation program in higher education because the belief systems these future teachers bring with them play an instrumental role in how they view their role as a teacher, think about teaching tasks, and ultimately make decisions once they are in a classroom (Bryan, 2003). According to Ucar (2012), these beliefs may be developed and enhanced as TCs progress through teacher education programs. As a result of effective instruction in methods courses, TCs' belief systems may be amenable to change (Bryan, 2003), making undergraduate methods courses an ideal time to explore beliefs about teaching and learning. Because the beliefs that teachers have influence a variety of teaching practices, from instructional methods to assessment models (Keys & Bryan, 2001), knowing the beliefs that TCs hold will help science methods educators determine the types of experiences they need to become effective science teachers (Bryan, 2003; Ucar, 2012). At this level, however, teacher educators often overlook the educational beliefs and experiences the TCs bring with them to their coursework (Bryan, 2003; Weinstein, 1989), wasting an opportunity to use this information to facilitate TCs' abilities to teach more effectively.

Statement of the Problem

In my work with teacher candidates enrolled in an elementary science methods class at a four-year university, the topic of interdisciplinary work is the focus of one chapter from the textbook as well as several days of class instruction. In working with the students, I learned that there are many opinions about the value of incorporating fictional literature into science instruction. While there is a significant amount of scholarly literature about the value of interdisciplinary work in science instruction (Bradbury, 2014; Contant, Bass, & Carin, 2014; Dickinson, 1996; Fleener & Bucher, 2003; Girod & Twyman, 2009; Hapgood & Palincsar; 2007; High & Rye, 2012; Luna & Rye, 2015; Nixon & Akerson, 2002; NRC, 2012; Osborne, 2002; Ostlund, 1998) contributing to greater student learning and understanding, the majority focuses on integrating science and mathematics. Although some authors do address the integration of language arts into science instruction, the majority of the work focuses on using non-fiction text as a support for science (Varelas & Pappas, 2006), and there is a dearth of research that addresses teacher candidates' thoughts and beliefs about blending the two disciplines through the use of fictional literature in elementary science instruction. It is important to understand teacher candidates' thoughts about this topic to frame discussions about interdisciplinary work in undergraduate methods courses, and specifically about the use of fictional literature as a teaching tool in science.

Purpose of Study

Given the lack of focus on incorporating fictional literature into elementary science instruction, it is not surprising that there is a lack of research that addresses TCs' thoughts about this topic. Therefore, the purpose of my dissertation study was to examine the perceptions of teacher candidates (TCs) about the integration of fictional literature in elementary science instruction.

Research Questions

The research question guiding this study was: What are the thoughts, feelings, and beliefs held by teacher candidates regarding the integration of fictional literature into elementary science instruction? Sub-questions included: 1) What benefits do teacher candidates perceive in integrating language arts/fictional literature and science? 2) What disadvantages do teacher candidates perceive in integrating language arts/fictional literature and science? 3) What impact, if any, did the teacher candidates' own experiences in elementary science have on their thoughts? The research question was designed to explore TCs' understanding of the use of literature to teach elementary science. According to Watts and Stenner (2012), questions that focus on participants' understandings should be explored in relation to their life experiences. Therefore, the third sub-question was an important component of this study, and lent itself to a constructivist approach to the analysis of participants' responses. Because Watts and

Stenner (2012) and Simons (2013) advocated for straightforward and clearly worded research questions to simplify the process for the participants, the research question presented to the participants during the data collection process was: What role, if any, should fictional literature play in elementary science instruction?

Overview of Methods

Participants were recruited from two sections of students taking a summer session elementary science methods course at an ethnically diverse four-year university with enrollment just under 40,000 students. Data was collected through a blend of Q Methodology, explained further in the next paragraph, and focus groups. Between the two sections, 38 students voluntarily chose to have their information included in the study. Additionally, two students from the first section and five students from the second participated in the two focus groups, giving me seven focus group participants total.

Q methodology is designed to capture personal beliefs and perspectives. In Q methodology, participants' perspectives about a topic are compared to other participants' perspectives, thus correlating views (Barnes, Angle, & Montgomery, 2015). This methodology requires participants to prioritize their beliefs by sorting a set of statements (Barnes et al., 2015; Brown, 1993; Watts & Stenner, 2012). In this study, the statements were created from a mix of the volunteers' responses to survey questions about integrating literature into science instruction as well as existing scholarly literature about the topic. The participants were asked to sort this set of statements into the following categories: agree, disagree, or neutral. Within each category, they ranked the statements with which they most agreed, followed by most disagreed, with neutral falling somewhere in the middle. Once the sort was completed and participants recorded their responses, volunteers were requested for the focus groups.

During this focus group discussion, the volunteers picked their own pseudonyms so as to protect their identities. Once the focus groups were completed, the audio recordings were transcribed; I checked them for accuracy and analyzed the data from the Q methodology card sort, correlation matrices, and factor arrays, as well as the focus groups, to look for emerging patterns, categories, and themes based on my understanding of the data, the research literature, and the research questions. I used Yin's (2011) analysis approach to examine the focus group data. After compiling the transcript data, I disassembled it and assigned codes to significant portions of the data. Following that, I reassembled the data in a list format to search for emerging themes, and used descriptions to "derive a deep understanding of the… conditions being studied" (Yin, 2011, p. 213).

Contributions and Significance of Study

Though there is not an obvious immediate connection to school improvement efforts, understanding the schemas that TCs bring with them to undergraduate methods courses will better enable university instructors to address potential misunderstandings or areas in which students need further instruction. Science methods instructors can use this information to guide their students to reflect on their views and understand their perspectives regarding children, literature, and science (Donovan & Smolkin, 2001), thus making improvements to the ways in which they address the use of literature to teach science during methods courses. Subsequently, this will enable TCs to be more effective once they are practicing teachers, and effective teaching contributes to increased student achievement and school improvement efforts (Adamson, et al., 2003; Harris, 2002;

Romance & Vitale, 2001). Since this dissertation explored TCs' perceptions regarding the integration of fictional literature into elementary science instruction, which in turn will help inform undergraduate science methods instructors about their viewpoints, there is the potential for a significant impact on TCs' teaching practices and their future students' understanding of and achievement in the field of science.

Theoretical Viewpoint

This study was qualitative in nature, with some quantitative elements, and I used both Q methodology and a constructivist approach to examine perceptions of teacher candidates about the integration of fictional literature into elementary science instruction. Ledoux and McHenry (2004) describe constructivism as "how one attains, develops and uses the cognitive processes that are involved in constructing knowledge" (p. 387). Using a constructivist approach assists a researcher in making sense of how learners construct their own learning and how existing understandings influence new learning. (Brophy, 2002). Ledoux and McHenry (2004) identified the constructivist approach as one that operates with a "focus on helping [students] form and develop conceptual models that will function as their own coding systems for the to-be-known world" (p. 387). Because this study sought to examine the perceptions of TCs who have yet to enter the teaching practice, a constructivist approach was appropriate.

Key Terms

Condition of Instruction— the research question followed by a statement or statements about what the participants will do during the Q sort (van Exel, 2005)

Constructivism—"how one attains, develops and uses the cognitive processes that are involved in constructing knowledge" (Ledoux & McHenry, 2004, p. 387)

Correlation Matrix—includes all of the gathered Q sorts; scores close to one show sorts that are highly correlated, while low or near zero scores reveal Q sorts that have comparatively little in common with the others (Watts & Stenner, 2012)

Factor—"identifies a group of persons who have rank ordered the provided items in a very similar fashion or, in other words, a group of persons who share a similar perspective... about the topic at hand" (Watts & Stenner, 2012, p. 22)

Factor Loading—a measure of the extent to which each Q sort exemplifies each factor; expressed as a correlation coefficient (Watts & Stenner, 2012)

Inquiry Based—a constructivist approach to teaching and learning; encouraged by the National Science Education Standards (Contant, Bass, & Carin, 2014)

Interdisciplinary (Integrated) Instruction— "connecting two or more disciplines with the intention to enhance learning" (Luna & Rye, 2015, p. 93)

Q Methodology—research technique designed to capture personal beliefs (Barnes et al., 2015)

Q Set—a set of statements given to participants for the sorting process; representative of the larger concourse (Watts & Stenner, 2012)

Q Sort (sort)—the rank ordering of provided statements into a prearranged frequency distribution (Watts & Stenner, 2012)

Scientific Literacy— "the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity" (NRC, 1996, p. 22)

Statement Concourse—the complete set of statements surrounding a topic obtained from literature, newspapers, novels, media reports, interviews, or participant observation; can also include paintings, photographs, musical selections, pieces of art, or cartoons (Watts & Stenner, 2012)

Teacher Candidates (TCs)—students enrolled in a teacher preparation program

Organization of the Remainder of the Study

Chapter two presents a review of the literature surrounding the topic of interdisciplinary work, science, and language arts. The chapter is organized into eight main sections: 1) why science instruction is essential in elementary schools; 2) the value of integrating science and language arts; 3) the decline in science instructional time in elementary school; 4) potential arguments against using literature to teach science; 5) the effects of background experiences on instructional practice; 6) an overview of the lack of emphasis on interdisciplinary work, and in particular the integration of science and language arts, in methods courses and in national publications and standards regarding science; 7) concluding remarks; and 8) a constructivist theoretical perspective as a unifying theme for making sense of these pieces as a whole. Chapter three presents the research methodologies I used to explore the research question guiding this study. In each section, I provided an overview of the methodology, then described how each component was implemented in this study. Chapters four and five present the data along with interpretations. In chapter six, additional noteworthy findings are identified, along with implications for practice, policy, and research.

II. REVIEW OF THE LITERATURE

I know growing up I never believed I was good at science or could ever be good at it, so I shut the door on being interested. But science is such an extraordinary field – so much can be done in it and through it and students need to be shown that.

-Meagan C. (undergraduate science methods student)

Introduction

The primary goal of this study was to understand a select group of teacher candidates' perspectives regarding the integration of literature into elementary science instruction. By exploring their beliefs, this analysis contributes to the growing body of work surrounding perspectives of pre-service teachers. In uncovering perspectives of undergraduate students' belief systems regarding this aspect of science instruction, the hope is that it will inform science methods teachers and contribute to revised modes of methods instruction, which may, in turn, impact these future teachers' practice. This chapter is organized into eight main sections, with subsections throughout. In section one, I explained why science instruction is essential in elementary schools, and I explored inquiry based learning as a "best practice" for effective elementary science instruction. In section two, I elaborated on the value of integrating science and language arts, with subsections on (a) skills, strategies, and processes that are shared by these two disciplines, (b) literature as a tool to support inquiry-based science learning, and (c) additional benefits to using fictional literature in science instruction, including the potential impact on English Language Learners (ELLs). In section three, I examined the decline in science instructional time in elementary school and suggested integrating the disciplines of science and language arts as a means of providing additional time for science. In section four, I outlined reasons why literature may cause misunderstandings in science, and offered suggestions to avoid that. In section five, I reviewed the research surrounding the effects of teachers' personal background experiences on instructional practice. In section six, I provided an overview of the lack of emphasis on interdisciplinary work, and in particular the integration of science and language arts, in methods courses designed for the preparation of teachers and in national publications and standards regarding science. In section seven, I provided some concluding remarks about the literature. In the final section, I explored a constructivist theoretical perspective as a unifying theme for making sense of these pieces as a whole.

I never realized how important science was until I took this class. Growing up, science was never projected to be fun, entertaining, hands-on, or important. When I think back to my younger years, science classes are not in any joyful memories.

-Lacy A. (undergraduate science methods student)

Elementary Science Instruction

Why science instruction is needed in elementary schools. According to the National Science Teachers Association (NSTA), inquiry science should be a basic part of the daily curriculum for every elementary aged student at every grade level because science education reform reports stress the importance of early experiences in science (Contant et al., 2014; NRC, 1996; NSTA, 2002). Early exposure to science experiences will help students learn to think critically about the world around them so that they can begin to build scientific literacy. Though the term scientific literacy appears less frequently in more recent national science education documents such as *A Framework for K-12 Science Education: Practices, Cross-Cutting Concepts, and Core Ideas* (National Research Council (NRC), 2012), hereafter known as *The Framework* and *Next Generation Science Standards, known as NGSS* (NGSS Lead States, 2013), it is still an essential component of science education (Roberts & Bybee, 2014). Encouraging students to be scientifically literate helps them be well-rounded individuals since it encompasses "the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity" (NRC, 1996, p. 22). Lifelong scientific literacy is established in the earliest years when teachers and students work together to build those understandings, attitudes, and values (NRC, 1996).

The NSTA position statement on elementary science instruction highlights key reasons why science instruction should begin at an early age, some of which are noted in Table 2-1:

Table 2-1: Key concepts in the NSTA position statement on elementary school science. (NSTA, 2002)
The elementary science program must provide opportunities for students to develop understandings and skills necessary to function productively as problem-solvers in a scientific and technological world.
Elementary school students learn science best when—
a. they are involved in first-hand exploration and investigation and inquiry/process skills are nurtured.
b. instruction builds directly on the student's conceptual framework.
c. content is organized on the basis of broad conceptual themes common to all science disciplines.

d.	mathematics and communication skills are an integral part of science instruction.
Elementary school students value science best when—	
a.	a variety of presentation modes are used to accommodate different learning styles, and students are given opportunities to interact and share ideas with their peers.
b.	the scientific contributions of individuals from all ethnic origins are recognized and valued.
c.	**other subject areas are infused into science.**
d.	**inquiry skills and positive attitudes are modeled by the teacher and others involved in the education process.**

Though all of the components are crucial, the items in bold are explored in more detail below since they relate directly to the concept of interdisciplinary work.

According to the NSTA position statement (2002), connecting other subject areas to science causes students to value it more. Luna and Rye (2015) stated there is a "lack of consistency in defining what constitutes curriculum integration, [though] it generally means connecting two or more disciplines with the intention to enhance learning" (p. 93). For the purposes of this analysis, the term *interdisciplinary* follows Luna and Rye's definition for curriculum integration. Using interdisciplinary strategies is important because they "have the capacity to reach the goals set forth by many state departments of education" (Ledoux & McHenry, 2006, p. 390). In addition to the infusion of other subject areas into science encouraging students to value it more (NSTA, 2002), Ledoux and McHenry (2006) stated three primary reasons for using an interdisciplinary approach to instruction, and in particular blending language arts and science. The first reason is that it helps students develop coding systems, or methods to connect what they already know to what they are learning. The interdisciplinary approach "allows for the simultaneous construction of both propositional knowledge of facts, concepts, and generalizations and procedural knowledge of how to apply selected concepts as strategies" (p. 391). The development of these coding systems mirrors the natural world "where there are no boundaries separating the processes of language arts from the content of science" (p. 391). This is the second point; interdisciplinary studies afford students natural opportunities to observe and make connections across the disciplines and construct new meaning, much as they would when making daily decisions or solving problems (Ledoux & McHenry, 2006). Their third point is that using an interdisciplinary approach will enable instructional planning and implementation to become much more efficient (Ledoux & McHenry, 2006), which is necessary in a time when "An already overcrowded curriculum is being stretched to accommodate [an] ever-growing body of knowledge while meeting increasingly stringent state standards and the call for accountability" (p. 392).

Inquiry based learning: A best practice approach to science instruction. In reviewing course descriptions from undergraduate science methods courses, examining texts used in these courses, and looking at national publications regarding science and science reform efforts, there does not appear to be an overt emphasis on connecting science with language arts, and more specifically incorporating fictional literature into elementary science instruction. With this apparent lack of emphasis, is combining language arts and science strategies actually an important component of a well-rounded elementary science curriculum? In a word: yes.

One important facet of teachers assisting students in constructing meaning is by helping them access prior knowledge (Contant et al., 2014; NSTA 2002; Romance &

Vitale, 2010). Contant et al. (2014) highlighted strategies teachers can use to tap into students' prior knowledge:

- Write initial descriptions and explanations of phenomena
- Construct concept maps of what they know
- Draw pictures and label diagrams of events, accompanied by written explanations; and
- Present their ideas to the class so that alternative descriptions and explanations might be considered (p. 235)

Writing, constructing concept maps, and communicating ideas are essential to both science and language arts. It is this need to access students' prior knowledge that "may explain the importance of involving students in exploration with hands-on materials or real-world experiences ***before*** introducing technical vocabulary or asking them to make sense of science text materials" (p. 235). Engaging students by accessing their existing understanding is a key feature of inquiry based instruction, which has been emphasized in preservice science teacher education for over a decade (High & Rye, 2012; NRC, 1996) as a best practice for enhancing students' understanding of science content.

According to Lind (2005), "Inquiry refers to the abilities students should develop to be able to design and conduct scientific investigation, and the understanding they should gain about the nature of scientific explanation" (p. 6). To be most effective,

> Activities in science classrooms should involve observations, questioning, reading books and other sources of information, investigating, gathering, analyzing, predicting, explaining, and communicating results. Memorizing facts will not

increase skills in students of science, but the freedom to explore and investigate through inquiry-based learning (IBL) will. (Maxwell et al., 2015, p. 3)

The concept of IBL appeared in the 1996 *National Science Education Standards (NSES)*, where the NRC outlined the benchmarks students in grades K-4 should reach to obtain competency in inquiry: "(1) ask questions which can be answered with scientific knowledge; (2) plan and conduct a simple investigation; (3) employ simple equipment to gather data; (4) use data to build a reasonable explanation; and (5) communicate explanations based on investigation" (p. 122). While the *NSES* do not prescribe curriculum to achieve this, they do describe what students should know and be able to do across the grade levels. According to Contant et al. (2014), "The central message that the *NSES* content standards convey… is that students should be engaged in an inquiry approach to learning science" (p. 13).

Several approaches to inquiry are explored in the *NSES*, including hands-on investigations, using Internet resources, talking with and listening to scientists and teachers, and reading books, among others (Contant et al., 2014; NRC, 1996). The suggestion that reading books is an important part of IBL (Contant et al., 2014; Maxwell et al., 2015; NRC, 1996) emphasizes the need for interdisciplinary work between science and language arts. A companion work to the *NSES* (NRC, 1996), *Inquiry and the National Science Education Standards, A Guide for Teaching and Learning* (NRC, 2000), also identified five essential features of inquiry in the classroom (Table 2-2).

Table 2-2: Essential features of classroom inquiry and their variations.

Essential Feature	Variations 1	2	3	4
1. Learner engages in scientifically oriented questions.	Learner poses a question.	Learner selects among questions, poses new questions.	Learner sharpens or clarifies question provided by teacher, materials, or other source.	Learner engages in question provided by teacher, materials, or other source.
2. Learner gives priority to **evidence** in responding to questions.	Learner determines what constitutes evidence and collects it.	Learner directed to collect certain data.	Learner given data and asked to analyze.	Learner given data and told how to analyze.
3. Learner formulates **explanations** from evidence.	Learner formulates explanations after summarizing evidence.	Learner guided in process of formulating explanations from evidence.	Learner given possible ways to use evidence to formulate explanations.	Learner provided with evidence and told how to use evidence to formulate explanations.
4. Learner connects explanations to scientific knowledge.	Learner independently examines other resources and forms the links to explanations.	Learner directed toward areas and sources of scientific knowledge.	Learner given possible connections.	
5. Learner communicates and justifies explanations.	Learner forms reasonable and logical argument to communicate explanations.	Learner coached in development of communication.	Learner provided broad guidelines to use and sharpen communication.	Learner given steps and procedures for communication.
	< More .... Learner Self-Direction .... Less > < Less .... Direction from Teacher or Material .... More >			

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Several features, including summarizing, communicating, making connections, and responding to questions, are common to both science and language arts, again demonstrating the need for interdisciplinary work, though not overtly stated. The follow-up to the *NSES (*1996), *The Framework* (2012), expanded the definition of scientific inquiry to include scientific practices such as observing, measuring, and recording, in addition to communicating results.

IBL offers a myriad of benefits to students' ability to learn science. It advances their process skills, fosters a positive attitude toward school science, stimulates motivation to learn science, and enhances communication skills, among other factors (Deters, 2005; Lord & Orkwiszewski, 2006; Qablan & DeBaz, 2015). IBL takes multiple forms in the elementary classroom. It can vary from highly directed by the teacher, the form with which many current undergraduate science methods students are familiar (Bryan, 2003; Dickson & Kadbey, 2014; Kazempour, 2014), to free range explorations; the form used by the teacher depends on the goals of the lesson (Contant, et al., 2014), and teachers are encouraged to utilize the full range of inquiries (NRC, 2000), though the use of open inquiry is "the purest form of inquiry conducted in the science classroom" (Contant, et al., 2014, 98).

One current model of inquiry, as shown in Figure 2-1, breaks down the four levels of inquiry based on how much information is provided to the students (Bell, Smetana, & Binns, 2005).

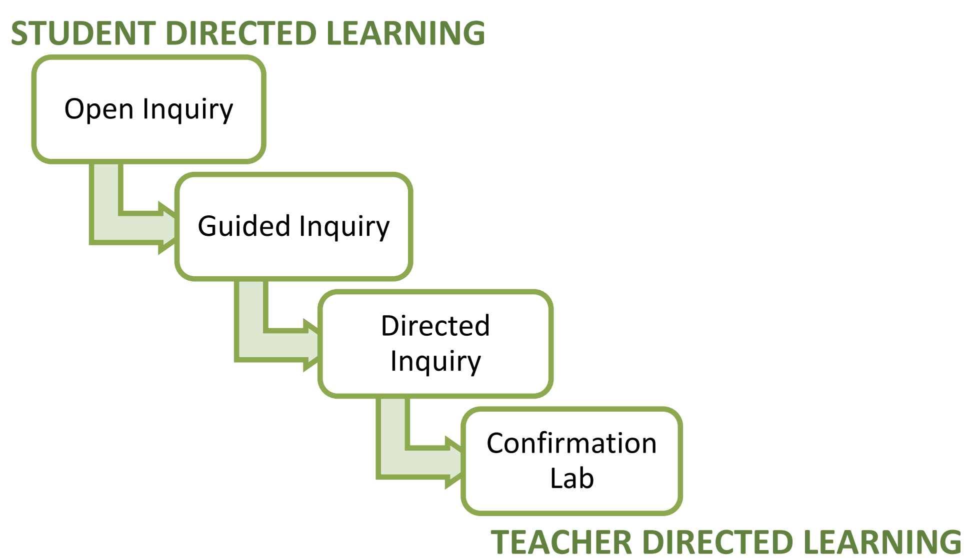

Figure 2-1: Levels of inquiry

Open inquiry is "the highest level of classroom inquiry…[and] requires the most scientific reasoning and cognitive demand on students" (Contant et al., 2014, p. 98). It requires the least amount of teacher direction and intervention in student learning and is characterized by students working in groups to determine a question or problem, devising steps to solve the problem, carrying out an investigation, and communicating their results. Guided inquiry mirrors the practices of open inquiry, but the teacher provides the question or problem. Other than that, the teacher serves as a facilitator only, with students directing the learning process. Structured inquiry, or directed inquiry, provides a little more scaffolding for students, with teachers providing the problem and procedures students should follow when exploring the topic, then providing space for students to explore the results for themselves. Confirmation activities are fully teacher directed and often include labs for students to verify what they have already learned from the teacher or the textbook. Though they may be "'hands-on' for the students, they are not really 'minds-on'… [and] many science educators do not consider confirmation activities inquiry at all" (Contant et al., 2014, p. 99). Because current methods students likely were exposed to confirmation activities in their own elementary science experience, purposeful instruction in the other forms of inquiry is essential in methods courses.

What unites the various forms of inquiry instruction is a shift from teacher-centered to student-centered classrooms (Contant et al., 2014; Ford, Fifield, Madsen, & Qian, 2013). TCs enrolled in science methods courses likely experienced more teacher-directed classroom instruction as they progressed through elementary school (Bryan, 2003; Dickson & Kadbey, 2014; Kazempour, 2014), which then became part of their own teaching schemas. In addition, the science courses they take as undergrads likely rely on more traditional methods of instruction such as lectures, supplemental notes, and textbooks (Ford et al., 2013; NRC, 1996). Though there may be an active learning component, it often consists of confirmation activities rather than true student-directed inquiry (Ford et al., 2013). TCs' undergraduate courses are also likely separated by disciplinary boundaries, "providing few models for future teachers for the integrated content they will be expected to offer to their elementary learners" (Ford, et al., 2013, p. 1050). According to Ford et al. (2013), "the chasm between [elementary teachers'] science learning experiences as undergraduates and the demands they face when they enter their own classrooms is often vast and difficult to bridge" (p. 1050). Because the strategies and methods through which TCs learn science influence how they later teach it to their own students (Ford et al., 2013; Kagan, 1992), careful instruction in inquiry methods, including the interdisciplinary component of using literature to enhance and extend science instruction, is necessary to impact their practice as they move forward with their teaching careers.

Integrating the Science and Language Arts Disciplines

Given this strong push for IBL in elementary science, teachers need strategies to implement this in their classrooms in a way that offers opportunities for students to develop deeper understandings and connections. According to High and Rye (2012), "the teaching of inquiry-based science to young learners is likely best accomplished through science curricula that incorporate other disciplines, especially reading/language arts and mathematics" (p. 50). Because there is already sufficient literature calling for the blend of the science and mathematics disciplines (NRC 1996; NRC 2012), I will focus my attention on the benefits of blending science and reading/language arts, as well as specifically explore the benefits of using fictional literature as an important component of elementary science instruction. It is important to note that the use of fictional literature is a component of a well-rounded elementary science education. It is not intended to replace labs and hands-on explorations, but rather enhance and extend students' engagement with and understanding of the science content.

A framework for understanding and examining the science and language arts connection. As the research has indicated, science and language arts complement each other and there is tremendous value in blending the two disciplines (Bradbury, 2014; Century et al., 2002; Cervetti, Pearson, Bravo, & Barber, 2006; Contant et al., 2014; Dickinson, 1996; Dickinson & Young, 1998; Fleener & Bucher, 2003; Girod & Twyman, 2009; Hapgood & Palincsar; 2007; High & Rye, 2012; Luna & Rye, 2015; Nixon & Akerson, 2002; NRC, 2012; Osborne, 2002; Ostlund, 1998). However, State and federal policies have promoted mathematics and literacy teaching and learning in elementary school to such a degree that other disciplines, including science, have been marginalized (Cervetti et al., 2006; Contant et al., 2014; High & Rye, 2012). In response, Cervetti et al. (2006) developed a framework to help "guide teachers and curriculum developers… in shaping an appropriate and supportive role for text and for literacy practices in inquiry based-science" (p. 222). Rather than place the focus on language and literacy, they make the "knowledge, skills, and dispositions of inquiry-based science the 'end' of [their] work" (p. 221), and position language arts in a supporting role to help students think "critically and flexibly across the domains of knowledge and inquiry" (p. 222). Some of the questions that guided their work were: (1) "What skills, strategies, and processes are shared by these two curricular domains?" and (2) How can reading and writing be used as tools to support inquiry-based science learning?" (p. 223).

Skills, strategies, and processes common to science and language arts. Language arts and science complement each other since both urge students to utilize similar cognitive processes such as assessing evidence, making predictions, and drawing conclusions (Bradbury, 2014; Cervetti et al., 2006; Ostlund, 1998; Padilla, Muth, & Padilla, 1991). Carter and Simpson (1978) found that a "close examination of reading skills reveals that many are actually inherent in logical thought, and thus represent some of the most fundamental 'tools of the trade' for scientists" (p. 19). Explorations in both language arts and science allow an opportunity for students to synthesize information and develop logical explanations (Bradbury 2014; Padilla, et al., 1991). Additional cognitive processes common to both disciplines are inductive and deductive reasoning, understanding analogies, speculation, developing insight, extrapolation, synthesis, and evaluation (Ostlund, 1998). By integrating the two disciplines, teachers enhance students' cognitive abilities in all content areas, promoting academic achievement.

As described in a previous section, inquiry based learning is considered a best practice in elementary science instruction (Contant et al., 2014; NRC 1996). Throughout the scientific inquiry process, elements of writing, reading, speaking, and listening are used to enhance students' understanding of science content (Table 2-3).

Table 2-3: Science inquiry and literacy connections.

Stages of Inquiry*	Writing	Reading	Speaking and Listening
1. Engage and Explore · wonder · notice · interact with organisms, objects, and phenomena	Purposes · think · reflect Types of writing · note taking · descriptive · speculative	Purposes · inspire · raise questions · enrich Types of books · fictional reality · wonder · personal experi-ences · biographies	Purposes · share ideas and wonder · generate questions · build vocabulary Types of settings · small-group discussion · one-on-one · informal large-group discussions
2. Design and Conduct Scientific Investigations · identify question · plan and implement an investigation · observe systematically · gather and organize data	Purposes · document process and data · save emerging thoughts Types of writing · procedural · data display · descriptive · technical · graphic	Purposes · provide examples of investigations · extend experience · provide informa-tion and vocabu-lary Types of books · experiment · field guide · information	Purposes · discuss strategies and ideas · clarify procedures and data collection · listen to others' ideas
3. Analyze and Interpret Data · identify patterns and relation-ships · develop descriptions, explanations, models, and predictions using evidence	Purposes · clarify thinking · communicate ideas · raise new questions Types of writing · analytic and interpretative · descriptive, explanatory model building · predictive · reflective	Purposes · support and validate ideas · provide informa-tion · raise new questions Types of books · information · reports · scientific note-books	Purposes · organize thinking · argue based on evidence · reflect on data Types of settings · small-group analysis · small- and large-group presentation and discussion
4. Present Findings and Understand-ings · organize findings and understandings · develop report using a variety of media · present, publish, report	Purposes · communicate clearly to others Types of writing · reporting · formal	Purposes · exemplify writing styles and presenta-tion strategies · provide alternative models Types of books · information · scientific report · text	Purposes · communicate formally · listen and argue clearly Types of settings · formal presentation · debate

Reprinted from "Supporting the science-literacy connection," by Century et al., 2002, p. 43. In Bybee, R. W. (Ed.) Learning science and the science of learning (pp. 37-49). Arlington, VA: National Science Teachers Press. Copyright 2002 by The National Science Teachers Association. (permission granted for use).

The stages of inquiry in the left-hand column are drawn from the *NSES* (NRC, 1996). The other three columns detail various uses of language arts components that enhance science learning and understanding. However, the manner in which they are taught and used is as important, if not more so, than the mere fact that interdisciplinary work is occurring. For example, if students use books simply as a way to copy information during the analysis and interpreting phase, they may have little understanding of what they read (Century et al., 2002) and not meet the goals of either discipline. Reading to acquire information, writing to share information, and communicating ideas are important skills in language arts, and they are essential to scientists as well.

There is further evidence that science and literature blend well together. For instance, in both subject areas "students incorporate their prior knowledge with new information and experiences to construct meaning" (Bradbury, 2014, p. 467), and students are active participants in the process. Thus, in both, students must engage with the content in order to comprehend it. By using literature to support science concepts, students can "develop more complex understanding[s] as new concepts are assimilated into the current knowledge structures" (Casteel & Isom, 1994, p. 54). This mirrors what is known about TCs and the impact their prior understandings, i.e. their own experiences in elementary science, have on their future teaching practice (Bryan, 2003; Dickson & Kadbey, 2014; Eick & Reed, 2002; Russell & Martin, 2014; Skamp & Mueller, 2001). Regardless of whether the student is in elementary school or enrolled in an undergraduate methods course, prior knowledge plays a significant role in the creation of new knowledge. By incorporating language arts strategies into science instruction, teachers at all levels can aid students in better comprehending science concepts.

Cervetti et al. (1996) found that comprehension strategies typically associated with language arts and inquiry strategies typically connected to science share a set of important functions that contribute to deeper student understanding. They assert that these comprehension strategies are "both designed to help students monitor their learning—to help students plan an approach to the task ahead, evaluate the outcomes of their efforts, and revise them as needed" (p. 232). By blending both together, students are able to construct more complete and complex understandings as they acquire new information through a variety of means. Teachers who are skilled in bringing together and encouraging students to use diverse sources of information—from text-based, to personal experience, to hands-on experimentation—guide students to "both understand ideas ('Oh, I get it!')…build a coherent account of [a] full array of ideas ('Oh, I see, this goes with this.'),…and connect them with other experiences and ideas already available in schema-like structures in long-term memory ('Oh, this is sort of like…')" (p. 232).

In addition to shared goals and functions, comprehension strategies in both language arts and science have common strategies that support the construction of meaning (Cervetti et al., 2006). In both disciplines, activating prior knowledge is essential since it prepares students to make connections, draw conclusions, and consider new ideas. Further shared strategies include establishing purposes and goals for learning as well as making and reviewing predictions. According to Cervetti et al. (2006), "prediction builds purpose in either domain; you read on or work on to see whether your prediction turns out to be accurate" (p. 233). Some final common strategies include drawing inferences and conclusions, a high-level interpretive skill in both disciplines, and recognizing relationships to deepen understandings. Through "making connections across a range of experiences and information and by discerning relationships of various kinds, including cause and effect relationships and comparison/contrast relationships, among others" (p. 233), students are able to broaden their understandings of new information.

Though there are variations in instructional approaches in both language arts and science, Bradbury (2014) found a significant amount of processes in common for the construction of new knowledge in both disciplines. For students to develop full meaning of science concepts, they need more than just doing science in a lab. For them to "gain insights and understanding of the manner and nature of scientific reasoning, [teachers] must offer them [an] opportunity to use and explore that language, i.e. to read science to discuss the meaning of its texts, [and] to argue how ideas are supported by evidence" (Osborne, 2002, p. 204). However, "despite this recognition that text is a fundamental part of the scientific enterprise, there is at the same time strong apprehension about the use of text in school science, particularly in the inquiry science tradition and particularly with younger students" (Cervetti et al., 2006, p. 224). Therefore, explicit instruction in the benefits of blending these two disciplines during science methods courses is essential.

How can literature be used as a tool to support inquiry-based science learning? Cervetti et al. (2006) found a great deal of evidence for the convergence of science and literacy, the most significant of which was their understanding of the ways in which text can be used to support inquiry based science learning. Noting that not everything teachers want students to learn about science can be observed or tested in the classroom, as inquiry based teaching practices encourage, incorporating text broadens the range of content to which students are exposed (Cervetti et al., 2006). If a teacher adheres to a strictly hands-on approach, students may not arrive at a complete understanding (Cervetti et al, 2006; Palincsar & Magnusson, 2001; Varelas & Pappas, 2006). As Palincsar and Magnusson (2001) noted:

> The notion that inquiry must be exclusively activity based is problematic because, in fact, much of what we know about scientific reasoning has been acquired through the thinking and experiences of others; that is, through learning in a secondhand way. Frequently, although not exclusively, this secondhand learning can be facilitated with the use of text. (p. 152)

Using text provides opportunities for teachers to share information with students that they might not be able to discern through hands-on activities. Text may also connect the world outside the classroom to any firsthand investigations being done in the classroom. For example, students learning about life science may not have a chance to visit the habitats under study in person; through text and pictures, books can serve as a bridge between those outside environments and any hands-on investigations (Cervetti et al., 2006). Oftentimes, text is used in science in a more traditional manner, displaying facts and science concepts (Cervetti et al., 2006). However, text may also present information incidentally if it is not a reference book or an "all about" book (e.g. a book all about the solar system). Exploring a variety of texts on a topic also enhances students' learning. Effectively using texts in this manner may "stimulate student thinking and guide students to make increasingly sophisticated connections among those texts" (Roth, 2014, p. 377).

In addition, text can be used to stimulate students' interest prior to engaging in hands-on experimentation, serving as a starting point to stimulate students' questions about the world around them. In a study by Anderson, West, Beck, Macdonell, and Frisbie (1997), students read books to encourage wonderings about a scientific topic, then developed questions about the topic prior to conducting investigations to answer the questions. The text prompted students to develop their own questions and carry out their investigations based on the reading, a form of open inquiry that requires high levels of scientific reasoning and cognitive demand (Contant et al., 2014). Combining literature and science requires students to use high levels of cognition. According to Romance and Vitale (2001), blending the two disciplines has the potential to improve both students' science knowledge and reading achievement. In blending literature with elementary science content, teachers may be able to increase students' engagement with and understanding of science; these improved instructional practices "should result in improved science… achievement of their students" (p. 940). They also found that students developed a more positive attitude towards science.

Value of incorporating fictional literature into science instruction. When text is used as a part of elementary science instruction, it is typically some form of science textbook (Donovan & Smolkin, 2001; Finley, 1991), which children in these grades often have a difficult time comprehending (Casteel & Isom, 1994, Contant et al., 2014; Donovan & Smolkin, 2001; Finley, 1991; Holliday, 1991) due to factors outlined by Contant et al. (2014):

- They tend to include technical vocabulary, unfamiliar jargon, and lots of big words.
- Even simple words that students may know could have another meaning in science (e.g., volume).
- Their sentence structure is complex, and the passive voice, which may be unfamiliar to students, is used.

- The presented information is often very dense, with so many concepts on a page that it seems overwhelming to the reader.
- Since the precise meaning of each word or clause may be important, they require "close" reading so that information can be extracted accurately.
- They present information through a mix of words, charts, tables, graphs, diagrams, symbols, and equations.
- Visuals may be confusing and difficult to understand. (p. 235)

When textbooks are used as the primary source of information and means of incorporating reading with science, students face significant challenges. Upon reading science textbooks, students are expected to set aside their own preconceived notions and accept new ideas solely based on the basis of the text's authority, which can be a challenging task for students at any age (Finley, 1991). If a students' prior knowledge does not align with the information in the text, or students do not have prior experience with the information presented, it is very difficult for students to formulate a complete understanding of the science concept. In addition, new concepts may not include explanations that make sense for students, especially at an elementary age, which causes confusion and may lead to incorrect ideas about significant science concepts (Holliday, 1991; Roth, 1991).

Although using textbooks may present some challenges for students, it is one way in which teachers can bring reading into science instruction to extend student learning. An overview of the ways text (not solely textbooks) can be used to support science through shared skills, strategies, and processes was provided in the preceding sections. However, as Cervetti et al. (2006) noted, in general there is a reluctance to use text in elementary school science, despite its many benefits. In discussing this reluctance, Cervetti et al. were referring to various types of non-fiction text; there is an even greater lack of understanding about how fictional literature can be used to support science instruction. In addition to the reasons outlined above, using fictional literature as a component of elementary science instruction has some added benefits that may enhance students' comprehension of and appreciation for science.

Being able to read and discuss science content are "higher level thinking practices similar to those used by elementary teachers when they use good literature for reading instruction" (Fleener & Bucher, 2003, p. 76). This is particularly important when using fictional literature to support science instruction, since students have been exposed to story-form since beginning formal instruction in school. In scientifically-themed fictional literature written for younger students, concepts and information often are presented by blending fact with fiction and use narrative to weave the facts through a story. According to Stanaway (n.d.), "The applied nature of scientific thinking as told through children's literature emphasizes the useful and relevant learning of content. With the inclusion of carefully selected children's literature, scientific ideas are presented which allow students to apply content to multiple situations and applications" (p. 2). Additionally, because "literature written in narrative style provides familiarity for linking personal experiences and feelings with factual information and new concepts" (Fleener & Bucher, 2003, p. 77), fictional literature provides a foundation on which to build and develop students' understanding of science concepts.

Kaser (2001) and Raymo (1992) both stressed the importance of fictional literature stimulating students' imagination and curiosity, two important aspects of science that may not occur solely through the use of informational text. According to Raymo (1992), “In children's books we are at the roots of science — pure, childlike curiosity, eyes open with wonder to the fresh and new, and powers of invention still unfettered by convention and expectation” (p. 562). Through using fictional literature, teachers are able to encourage students to view science as much more than just a set of facts to be memorized. Because “Stories make a difference in how we live, how we think, and in what the imagination can conceive; it is the storying that will bring the science to the children” (Kaser, 2001, p. 355). Raymo (1992) was particularly concerned with cultivating a scientific attitude in students. He emphasized that the best time to do this is during childhood and the best strategy teachers can employ is to use quality children’s books.

> Let's not be too overly concerned about providing science facts to children. A child absorbs quite enough science facts from school and television, from computers and the other rich technologies at the child's disposal. If we want to raise children who will grow up to understand science, who will be citizens who are curious, skeptical, undogmatic, imaginative, optimistic, and forward-looking, then let's turn the Victorian rule [of imparting strictly factual knowledge] on its head and put into the hands of children books that feed imagination and fantasy. There is no better time to acquire scientific habits of mind, and no better instigator than quality children's books. (Raymo, 1992, p. 567)

Raymo (1992) argues that informational science books for children, including textbooks, might actually diminish the habits of mind—curiosity, voracious observation, fantasy, and variations within rules, among others—that make for good science. In using fictional literature, teachers may open "students up to looking at commonly accepted phenomena through different eyes or from a different perspective…[which is] the same thing as scientists do in their work" (Kaser, 2001, p. 350). Using fiction allows teachers to connect with characteristics inherent in children, and engage and build upon their natural curiosity and wonderment about the world. Science-themed fictional literature has the benefits of the shared cognitive processes in science and language arts such as assessing evidence, making predictions, and drawing conclusions along with the additional benefits of stimulating imagination and curiosity. It is underutilized in elementary science instruction, and deserves more recognition as a powerful teaching tool.

Fictional literature and English Language Learners (ELLs). The benefits of integrating fictional literature in science is of utmost importance to ELLs as well, considering that classrooms in the United States and particularly in Texas have become more linguistically and culturally diverse (Shaw, Lyon, Stoddart, Mosqueda, & Menon, 2014; Song, Higgins, & Harding-DeKam, 2014). It is important that teachers in these diverse classrooms provide students ample opportunity to learn and succeed in science (NRC, 1996; Song et al., 2014). The science classroom provides an excellent opportunity for the integration of language instruction with content instruction through which to engage ELLs (Nelson, 2010). According to Groce (2004), "By hearing and using language within the context of curricular experiences, children are more inclined to learn languages" (p. 122) along with the content. Because "One of the challenges ELLs encounter in learning science is to build scientific knowledge and skills while acquiring and developing their language proficiency" (Song et al., 2014, p. 52), blending the two disciplines is a useful strategy to promote interdisciplinary learning for all students. The practices outlined in *The Framework* (NRC, 2012) required for students' understanding of science—asking questions and defining problems, constructing explanations, engaging in argument, and communicating information—are language intensive and require students to use reading, writing, speaking, and listening, the four components of the English Language Proficiency Standards (ELPS), to successful engage with the science content (Song et al., 2014).

Two of Song et al.'s (2014) recommendations to enhance the learning experience for ELLs were to use children's books and conduct read alouds during science instruction. The use of an engaging children's story book "can spark students' interest in the science topic of study" (p. 53). For example, in *A Day Down the Candy Aisle*, a book about a character named Taylor who moved into a neighborhood with a significant amount of diversity, Taylor teaches her grocery store friends about getting along with each other in spite of their differences. Reading this story would likely catch the attention of culturally and linguistically diverse students, possibly affording them an opportunity to make a personal connection to the message. Following the reading of this story, Song et al. (2014) recommended having students observe the outside and inside of an M&M by using their five senses, an important skill in science, providing language supports where needed. Using M&Ms or other candies connects back to the setting in the story, and provides a link between the story elements and the science skills. In this example, the story was shared with the class as a read-aloud, where the teacher reads the story to the class. This is "useful especially for ELLs" (Song et al., 2014, p. 53) because it models fluency, builds background knowledge, and develops language acquisition.

The Decline in Science Instructional Time

By incorporating literature into science lessons, or utilizing literature with a science focus during language arts instruction, teachers may be able to increase the instructional time devoted to science (Ledoux & McHenry, 2004). This is particularly important since science, though one of the four core subjects, “is considered a lower priority subject in elementary school” (Dickinson, 1996, p. 3). Prior to the passing of the Elementary and Secondary Education Act (ESEA) in the early 2000s, the time devoted to science instruction in elementary school had been increasing (Blank, 2012). Since that time, however, the time devoted to math has increased slightly while the time for English language arts (ELA) has increased significantly (Blank, 2012). This leaves little time in the school day for other subjects and, “When time is short, science is often shortchanged in the elementary classroom” (Dickinson, 1996, p. 3). Blank (2012) found that a “National trends analysis shows a decline in time for elementary science instruction, and… a wide variability across the states in average class time spent on science education” (p. 3).

According to the NSTA (2002), science should be a basic part of the curriculum for every elementary aged student. Education reform reports stress the importance of early experiences in science helping students learn to think critically about the world around them and begin to build scientific understandings (Contant, Bass, & Carin, 2014; NRC, 1996). In the words of Raymo, (1992), the elementary age is when scientific “habits of mind” are formed in students. Lifelong scientific literacy is established in the earliest years when teachers and students work together to build positive understandings, attitudes, and values about science (NRC, 1996). Despite research showing the importance of early, frequent exposure to science for young students in elementary school, a significant portion of the day is set aside for language arts instruction. Because "science is often not allotted as many minutes during the school week as other subjects, whenever connections can be made between subjects to increase the amount of science that is taught, it is a great idea!" (Contant et al., 2014, p. 223). Being able to combine the ELA and science content areas is an important skill for prospective teachers to develop for a very practical reason; they may need to "borrow" time from one to have adequate time to cover the other. By incorporating literature into science instruction, teachers may be able to use time allotted to language arts to teach science.

Potential Drawbacks to the Integration of Literature into Science Instruction

While acknowledging that using literature in science instruction can be effective, Royce and Wiley (1996) enumerate reasons why it could potentially limit students' understandings. In some cases, "accuracy of science content sometimes suffers in a trade book's attempt to represent complicated information" (p. 3). When authors attempt to fit large quantities of information into limited space, information may become misrepresented in the text and illustrations which may lead to student confusion. One solution to counteract this is careful instruction in book selection during a methods course in a teacher preparation program. TCs need to be aware of the possibility of inaccuracy in the literature, and become well versed in selecting books that will enhance students' understanding rather than hinder it. Some additional concerns regarding the use of science trade books include "ensuring that stereotypes are avoided, that illustrations are accurate and labeled, that texts encourage scientific ways of thinking, and that science content is clarified by the organization of the book" (p. 3). They recommend asking questions such as "'Is the science concept recognizable?' 'Is the story factual?' and 'Is fact discernible from fiction?' to assist in avoiding the pitfall of using children's literature that fosters misunderstanding" (p. 4). If teachers are trained to select their books carefully and purposefully, these dangers can be avoided and literature can be a great tool for science instruction.

The other part of their concern has to do with the distinction between efferent reading and aesthetic reading as described by Rosenblatt (1991). While efferent reading is a way of reading for content, aesthetic reading focuses on the feelings and thoughts experienced by the reader as s/he reads. They believed that "science teachers may be encouraging efferent reading when aesthetic reading techniques might be used more appropriately to help students see the larger picture" (Royce & Wiley, 1996, p. 3). One reason this might be occurring is that "In most science teacher education programs, much attention is given to efferent reading, but less to the strategies used for aesthetic reading" (p. 3). Efferent reading occurs while reading non-fiction texts; if teachers use the text as a basis for a quiz over the content, students will become accustomed to reading solely in this manner to accumulate as many facts as they can. To counteract this, TCs in methods courses should be encouraged to use fictional literature, which lends itself to aesthetic reading in addition to efferent reading. When using children's literature in science, teachers must be keenly aware of the strategies they employ because "At times, science teachers may be encouraging efferent reading when aesthetic reading techniques might be used more appropriately to help students see the larger picture" (p. 3).

The Impact of Teacher Candidates' Backgrounds on their Future Instructional Practice

Long before undergraduates enroll in a teacher preparation program to begin their formal education in teaching methods, philosophy, and practice, they began their informal training. By the time teacher candidates (TCs) enter a teacher preparation program, they have already observed and participated in thousands upon thousands of hours of teaching as they progressed through their K-12 education. In this sense, they have lived the teaching experience by watching their own teachers and their instructional methods. Whatever strategies and practices their own teachers used became part of their schema of teaching, and helped shape their understanding of what it means to be a teacher (Bryan, 2003; Dickson & Kadbey, 2014; Eick & Reed, 2002; Russell & Martin, 2014; Skamp & Mueller, 2001).

The backgrounds that TCs bring with them to their undergraduate teaching methods courses impact their beliefs about teaching which, in turn, influence their receptiveness to new concepts and ideas introduced during methods courses. This holds true for all undergraduate methods courses, including those in science instructional methods. According to Dickson and Kadbey (2014), TCs "hold beliefs about science education embedded from their own experience prior to their teacher-training, particularly from their own schooling experience, which can be difficult to overturn" (p.332). Kagan (1992) also found that TCs' beliefs can be resistant to change. However, Skamp and Mueller (2001) found that "the influence of the student teachers' own schooling seemed to 'fade' [upon completing higher education courses], while university and practicum tended to assume approximately equal importance" (p. 241). Similarly, Bryan (2003) found that, by the time prospective teachers enter teacher preparation programs, their beliefs about teaching and learning are still malleable.

Additional research exploring the potential for TCs to change their attitudes and beliefs found that, with effective instruction, TCs may adapt the beliefs they held upon beginning a science methods course (Kazempour, 2014; Ucar, 2012). In a study by Dickinson (1996), she found that the work done in an undergraduate teacher preparation course had a significant impact on the ability of TCs to use language arts strategies with which they were familiar to successfully teach science content in their methods course. Through careful instruction, the TCs reframed their thinking about language arts and science, as well as the value of interdisciplinary instruction. Therefore, "understanding [future] teachers' beliefs about science teaching and learning will help science educators determine the types of experiences that are important for those teachers as they enter the profession" (Bryan, 2003, p. 836).

When a TC's K-12 science experience was a positive one, s/he is more likely to enter a methods course with an open and receptive mindset. Conversely, when a TC's K-12 experience in science was negative, finding ways to ignite an interest in teaching science may prove difficult. Because "the educational beliefs of prospective teachers play a pivotal role in how they interpret pedagogical knowledge, conceptualize teaching tasks, and subsequently enact their teaching decisions" (Bryan, 2003, p. 836), understanding the backgrounds and experiences TCs bring with them to methods courses is instrumental for teacher educators in a higher education setting. Throughout education courses, TCs are told that it is imperative for them to know their own students' backgrounds and that one must be able to tap into their prior knowledge to better make connections to new content (Content, Bass, & Carin, 2014). At the higher education level, however, teacher educators often overlook the educational beliefs and experiences that TCs bring with them to their coursework (Bryan, 2003; Weinstein, 1989), squandering the opportunity to use this information to facilitate TCs learning to teach more effectively. Regardless of whether the TCs' own experiences in science as they progressed through their schooling was positive or negative, understanding the impact of students' backgrounds is important for teachers at all levels of education.

Although TCs were exposed to a variety of teaching and learning methods as they progressed through school, much of the instruction during elementary science was teacher-centered (Dickson & Kadbey, 20414), positioning it opposite the currently recommended student-led inquiry models (Bell et al., 2005; Contant et al., 2014). Several researchers have studied TCs' backgrounds in an effort to understand the beliefs they hold about elementary science education; they found that relatively few hold positive beliefs about teaching science (Bryan, 2003; Dickson & Kadbey, 2014; High & Rye, 2012; Kazempour, 2014; Skamp & Mueller, 2001). As part of a study exploring one TC's belief system before and after enrolling in a science methods course, Kazempour (2014) found that the TC, a female, felt unsuccessful and disinterested in science prior to enrolling in her methods course because of unfulfilling science instruction during her K-12 schooling. This particular student had trouble remembering what she learned in elementary science because there was very little emphasis placed on this discipline, with lessons occurring only once or twice a week using instructional strategies like lectures, notetaking, and requiring students to complete worksheets (Kazempour, 2014). The "constant challenges, difficulties, and frustrations she experienced in her K-12 science courses… culminat[ed] in a sense of sheer intimidation and trepidation toward learning and teaching science" (p. 84) prior to taking a methods course.

In a longitudinal study by Bryan (2003), the TC's foundational beliefs about the purpose of science instruction she obtained during her own educational experiences influenced her tendency toward a didactic, teacher-centered approach to teaching science. Her interest in relying on the transmission of knowledge from teacher to student contradicted what is known about effective elementary science instruction (Content, Bass, & Carin, 2014; NRC, 2012), but reflected the teaching style she experienced in her own elementary education, a phenomenon common to many TCs. Bryan (2003) conducted this study from a constructivist perspective, choosing a qualitative approach to "capture the interaction among beliefs, experiences, and actions" (p. 837) in her participant, a 21 year old female elementary education major enrolled in a science methods course during Phase I of the study. Bryan (2003) conducted observations of the course environment and activities, audiotaped and transcribed large and small group discussions in which the participant engaged, analyzed over 20 of the participant's reflections about science teaching and learning posed by the course instructor, and conducted six interviews with the participant spanning the 16 week methods course. During Phase II, Bryan (2003) observed the participant during her student teaching experience and conducted 17 interviews with her during this time. A picture of conflict emerged; upon analysis, Bryan (2003) found that the participant "held dualistic beliefs about (a) how children learn science, (b) the science students' role, and (c) the science teacher's role" (p. 835). On the one hand, the science educational practices she experienced in her own education were so nested that they drove her practice towards a more didactic approach. On the other, she developed a strong vision of practice that included more of a hands-on approach to science education, even though some aspects of it did not transfer to her actual practice. Bryan (2003) concluded that, "the earlier prospective teachers have an opportunity to test their beliefs in practice, the earlier they can begin systematically to inquire into their practice and confront perturbations to their thinking" (p. 862).

For many TCs, the didactic approach they experienced in their own elementary education prompted a lack of interest in science and in teaching science. This uncertainty about science, and the teaching methods that prompted it, is not unique to the aforementioned TCs. Upon exploring the science schooling experiences of first and fourth year TCs, Dickson and Kadbey (2014) found that "most were highly critical of their teaching and learning experience at school and at what they perceived to be dominantly teacher-centered practices" (pp. 339-340). Though they were critical of their science experiences, having any type of science instruction during elementary school is unique, as science continues to be one of the more neglected disciplines in the elementary school curriculum (Bryan, 2003; Sivertsen, 1993).

An understanding of the beliefs TCs bring with them to undergraduate-level science methods courses is instrumental if the instructor intends to shape and define TCs' practices as they transition to becoming teachers of record. Because many facets of teaching, such as course content, types of assessment, and instructional methods are influenced by teachers' attitudes and beliefs (Keys & Bryan, 2001), "teacher education programs play an important role in the development of beliefs regarding teaching and learning" (Ucar, 2012, p. 255). The behaviors teachers exhibit in the classroom are subjective to their perceptions, judgements, and beliefs (Lumpe, Haney, & Czerniak, 2000; Pajares, 1992), many of which are modified during their undergraduate experience in education courses. These initial stages of a teacher's future career are an ideal time to explore beliefs because TCs' belief systems are amenable to change when they receive effective instruction in undergraduate courses (Bryan, 2003). Knowing the beliefs of TCs will help science methods educators determine the types of experiences they need to become effective science teachers (Bryan, 2003; Ucar, 2012).

Interestingly, though there is some research to show that understanding the beliefs TCs bring with them to methods courses is needed for effective instruction (Bryan, 2003; Dickson & Kadbey, 2014; Kagan, 1992; Kazempour, 2014; Skamp & Mueller, 2001; Ucar, 2012), the bulk of research on beliefs about science teaching and learning is focused predominantly on beginning and veteran teachers and teachers at the middle and secondary levels (Bryan, 2003). In actuality, little is known about the content of TCs' belief systems and the nature of the relationship between their beliefs and future practice (Bryan, 2003; Skamp & Mueller, 2001). Therefore, exploring TCs' beliefs about interdisciplinary work in science instruction and, more specifically, their beliefs about the use of fictional literature in elementary science, offers a promising area of research with hopes of promoting needed reform in higher education science methods courses. The goal of this study is to contribute to the understanding of teacher candidates' perspectives; "as this body of knowledge grows, the collection of studies can provide systematic information from which cautious generalizations about prospective science teachers' belief systems can be used to facilitate their development of professional knowledge in our science teacher education programs" (Bryan, 2003, p. 862).

The Emphasis (or Lack Thereof) Placed on Interdisciplinary Work in Elementary Science Instruction

At the institution where I teach, the undergraduate science methods course description in the most recent course catalog states:

> Course provides an overview of science standards and content, research-based science pedagogy, and the scientific process skills required for a developmentally appropriate, inquiry-driven science curriculum that facilitates the development of scientific literacy for all students, including second language learners. (Texas State University, 2015)

In all, eight key concepts appear in the course catalog description; not one includes interdisciplinary or integrated instruction. Though in the course catalog there is mention of developing scientific literacy and research-based science pedagogy, choosing not to include interdisciplinary work as a key component of the course description implies that the emphasis of the course lies elsewhere.

One might argue that the development of scientific literacy includes knowledge of how science and other academic disciplines combine, which would indicate a connection to interdisciplinary studies. The *National Science Education Standards* (1996) definition of scientific literacy states:

> Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena.

> Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately. (NRC, 1996, p. 22)

Being able to read articles with understanding, engage in conversation, express positions, and evaluate information are ideas that crosscut both science and language arts, which hints at interdisciplinary work. To make this connection, however, one has to dig through several layers of statements about science and science teaching to find this possible link and, even then, it is not stated explicitly. It can be inferred that the standards encourage interdisciplinary work to achieve scientific literacy but, again, the term interdisciplinary does not appear in the statement. The implication is there, but the emphasis is not.

In the years following the publication of the 1996 standards, the term *scientific literacy* has lost some favor. According to Roberts and Bybee (2014), "the terms scientific literacy and science literacy do not appear to play a significant role" (p. 545) in *The Framework* (NRC, 2012). This document serves as the basis for the *NGSS (NGSS Lead States, 2013)*, which are the most current national science standards. Upon analyzing *The Framework*, Roberts and Bybee (2014) found a trend toward "purifying science education policy through purging the attention to personal and societal perspectives [and] staying strictly with scientific and engineering aspects of the issues" (p. 550). Although combining science and engineering concepts, along with technology and mathematics (STEM) is interdisciplinary, placing the emphasis on these disciplines while relegating others to a minimal supporting role negates the entirety of what science can be. *The Framework* (NRC, 2012) identifies eight practices the NRC considers "essential for learning science and engineering in grades K-12" (NRC, 2012, p. 41):

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information (p. 42)

The focus primarily is on science and engineering practices. Although some of these are skills utilized in language arts as well—evaluating, communicating, analyzing, etc.—the focus is not on the interconnectedness of science with disciplines other than math and engineering.

Toward the latter part of *The Framework* (2012), the NRC makes recommendations for the writers of the *NGSS* (2013). Recommendation 12 of 13 states, "The standards for the sciences and engineering should align coherently with those for other K-12 subjects. Alignment with the Common Core Standards in mathematics and English/language arts is especially important" (NRC, 2012, p. 306). They identify this coherence as "critical" (p. 306) to ensure effective science education for students, beginning with elementary curriculum. The NRC (2012) acknowledges the value of interdisciplinary work for providing opportunities for reinforcement of new concepts and for bringing practices typically attributed to other disciplines into science education. Unfortunately, this mention of interdisciplinary work and, in particular, the value of combining science and language arts, is relegated to a brief passage at the conclusion of the document. Although they acknowledge "students' writing and reading, particularly nonfiction, can cut across science and literacy learning" (p. 306), there is no mention of the benefits of using fictional literature in elementary science instruction. In fact, one might infer that because they specifically point out the value of nonfiction, they are discounting fictional literature as having a place as a tool for effective science instruction.

In their position statement about science teacher preparation, The National Science Teachers Association (NSTA, 2004) affirms that they support teacher education efforts that align with the goals and guidance provided in the aforementioned *National Science Education Standards* (NRC, 1996). The NSTA position statement (2004) included several recommendations for science teacher preparation programs to promote the development of needed skills, knowledge, and attitudes in teacher candidates, among them "A structure for collaboration among education, science, engineering, and mathematics departments on the science teacher education course of study to ensure that prospective teachers have a solid foundation in the relevant science knowledge and skills each will teach" (NSTA, 2004, p. 2). Although the position statement asserted that teacher preparation programs should have some plan for interdisciplinary collaboration in place, again, the emphasis is on the connection between science, engineering, and mathematics. There is no mention of the positive aspects of integrating language arts and science, a profound oversight.

Further exploration of undergraduate science methods course descriptions at major universities around Texas (enrollment of 30,000+) comparable to the one at which I teach hints at the concept of interdisciplinary work, though again, that term does not appear in the course descriptions. At one university, the undergraduate course description for Approaches to Teaching Science EC-6 reads as follows:

> A study of pedagogical approaches, materials, and resources designed to support children's meaningful exploration, discovery, and construction of basic concepts and skills in EC–Grade 6. Emphasis in the course will be on the interrelatedness of science in the daily lives of students, unifying concepts and processes common to all sciences, development of effective learning environments for science both inside and outside of the classroom, planning and implementation of inquiry-based science lessons, assessment of student learning, and the use of an integrated approach to teaching. (The University of Texas at San Antonio, 2015)

The use of terms such as "integrated" and "interrelatedness" hints at the notion of interdisciplinary work; without access to the course materials, however, it is difficult to determine whether it is a focus of the course and, if it is, to what extent.

At another university, the course description for Teaching Science in the Elementary School stated, "Methodology of teaching appropriate science learning experiences to elementary school children. Field-based course" (Texas Tech University, 2015). Finding this description lacking, I reviewed the syllabus for the course and found a more detailed description:

> EDEL 4375 emphasizes the objectives, patterns, and principles of organization of science in the elementary schools. In this course, students will learn principles underlying the design and organization for teaching and learning in elementary science programs. Students will demonstrate increased professional competency and reflective decision-making as they engage in processes of planning, writing and utilizing science content within the classroom. (Nelson, C., 2016, p. 1)

There is still no mention of interdisciplinary work as an integral part of the course, although writing curriculum incorporates some language arts work for the TCs. However, that does not mean the connection between the disciplines will translate to their practice, nor does it imply the TCs were explicitly taught strategies to integrate science and language arts during curriculum planning.

In the science methods course I teach, we use *Teaching Science Through Inquiry and Investigation, 12th Edition* (Contant, Bass, & Carin, 2014) as our primary textbook; in all, it has 272 pages of learning content, with activities for teaching science in the appendices. Only one chapter out of ten is devoted to interdisciplinary work. Chapter nine, "Connecting Science with Other Subjects" (p. 222), is 18 pages long. Of those 18 pages, five are devoted to a subsection titled "How Can Science and English Language Arts Be Connected to Enhance Learning in Both Subjects?" (p. 232). That is five pages out of 272. While acknowledging that teaching science is a complex topic and the integration of language arts and science might not carry as much weight as understanding the nature of science and inquiry instruction, in my opinion, devoting only 1.2% of the content to this important topic does not highlight its importance enough.

Within this section, however, the authors make some valid arguments for integrating the two subjects, using *The Framework* (NRC, 2012) as the basis for their arguments.

> Being literate in science and engineering requires the ability to read and understand their literatures. Science and engineering are ways of knowing that are represented and communicated by words, diagrams, charts, graphs, images, symbols, and mathematics. Reading, interpreting, and producing text… are fundamental practices of science in particular, and they constitute at least half of engineers' and scientists' total working time. (p. 74)

Expanding on *The Framework* (NRC, 2012), Contant et al. (2014) asserted that "an emphasis on literacy across the curriculum is a natural way for students to learn and use language skills to communicate and reason" (p. 233) both in specific academic disciplines and in their everyday lives. Both language arts and science have a similar goal: the pursuit of meaning (Contant et al., 2014; Padilla et al., 1991; Santa & Alvermann, 1991). In the language arts, students construct meaning from text and, in science, students construct meaning from the natural world (Contant et al., 2014). Because of the differences in meaning-making, the approach to understanding the content in these two disciplines might seem to require different strategies. At the core, however, reading and science teachers "want their students to be able to describe events, make inferences, interpret information, draw conclusions, and make and test predictions" (Contant et al., 2014, p. 235), skills needed to be successful in both disciplines. By linking the two subjects, teachers will increase the likelihood that their students will have a better understanding of the content (Bradbury, 2014; Contant et al., 2014; Luna & Rye, 2015; Padilla et al.1991; Romance & Vitale, 2001). Even with this brief explanation of how science and ELA integrate together, there is still no mention of the value of fictional literature.

Concluding Remarks

In working with students enrolled in a science methods course at a four-year university, I learned that there are many opinions about value of incorporating fictional literature into science instruction. While there is scholarly literature about the value of interdisciplinary work in science instruction, the majority focuses on integrating science and mathematics. When authors do address the integration of literature into science instruction, the majority of the work focuses on using non-fiction text as a support for science (Varelas & Pappas, 2006). There is a dearth of research that addresses teacher candidates' thoughts and beliefs about integrating language arts and science through the use of fictional literature in elementary science instruction. The research clearly shows that there is value in blending the two disciplines (Bradbury, 2014; Century et al., 2002; Cervetti et al., 2006; Contant et al.,2014; Dickinson, 1996; Fleener & Bucher, 2003; Girod & Twyman, 2009; Hapgood & Palincsar; 2007; High & Rye, 2012; Luna & Rye, 2015; Nixon & Akerson, 2002; NRC, 2012; Osborne, 2002; Ostlund, 1998) for greater student learning and understanding. Therefore, it is important to explore teacher candidates' thoughts about this topic to frame discussions on interdisciplinary work and the value of using fictional literature as a tool for science instruction in undergraduate methods courses. Science methods instructors can use these discussions to guide their students to consider their views and "help them see what these choices indicate about their own stances regarding children, books, science, and science education" (Donovan & Smolkin, 2001, p. 438). Because "improvements in the way undergraduate science… courses are taught to preservice teachers should result in improvements in the way preservice teachers teach when they later become in-service teachers" (Adamson et al., 2003, p. 940), there is a potential for a significant impact on their teaching practice and their future students' understanding of and achievement in the field of science.

Theoretical Framework

This study was qualitative in nature, using a constructivist approach to analyze perceptions of teacher candidates about the integration of fictional literature into elementary science instruction. Especially in the field of education, the constructivist framework appears to be a "complex, multifaceted, and somewhat indefinable doctrine" (Mayer, 2004, p. 18). A brief overview of the cognitive theorists who helped shape constructivism will assist in defining the view of constructivism used in this study.

Constructivist teaching and learning is supported by the theories of both Jean Piaget and Lev Vygotsky (Brighton, 2007). Though there are many facets to constructivism, Vianna and Stetsenko (2006) identify several foundational premises that are common to both theorists. In their view, the broadest foundational premise of constructivism is that it "moves away from context independent notions of psychological processes toward the transactionalist view of social and psychological phenomena as processes embedded and co-constructed within contexts" (Vianna & Stetsenko, 2006, p. 84). According to Vianna and Stetsenko (2006), both Piaget and Vygotsky suggest that children learn as they interact with their environments, which is in "opposition to traditional views of mind as passive containers of knowledge and of learning as a process of acquiring fixed knowledge (facts and information) that are thought to exist independently of human activity" (p. 85).

Despite these commonalities, there are some marked differences in Piaget's and Vygotsky's views about learning. In Piaget's view, "children develop, learn, and achieve knowledge—all in the spirit of adapting to existing conditions in order to 'fit in' better with them and the environment as a whole" (Vianna & Stetsenko, 2006, p. 86). Children take in new knowledge and form a blueprint for a concept, known as a schema (Brighton, 2007). As they continue learning new information and gaining insight, the existing schema may need to be adjusted. If the new knowledge fits into the existing concept, it is assimilated. When the schema is modified to make room for new interpretations, it is accommodated (Brighton, 2007). In contrast, Vygotsky's views suggest that, "children develop and learn as they actively change the world they live in, simultaneously changing themselves and gaining knowledge of themselves and the world through changing the world" (Vianna & Stetsenko, 2006, p. 87). Vygotsky's views incorporated the ideas that one's culture and social contacts have a great degree of influence on one's cognitive development (Brighton, 2007).

Since the time of Piaget and Vygotsky, additional aspects of constructivism have emerged. Ledoux and McHenry (2004) describe constructivism as "how one attains, develops and uses the cognitive processes that are involved in constructing knowledge" (p. 387), which is consistent with Piaget's and Vygotsky's viewpoints. Within the constructivist epistemology are two characteristics identified by Applefield, Huber and Moallem (2001): learners construct their own learning, and new learning depends on students' existing understandings. Both of these components play key roles in this study, so it is this view of constructivism that will guide this research.

Research clearly shows that TCs enrolled in methods courses bring a set of beliefs about science teaching and learning established through their progression of their own experience in elementary science to those courses (Bryan, 2003; Dickson & Kadbey, 2014; Eick & Reed, 2002; Russell & Martin, 2014; Skamp & Mueller, 2001); these are their existing understandings. According to Tsai (2002), "constructivists may assert that people's subsequent actions and thoughts are mainly based on their ideas constructed earlier" (p. 771). Therefore, teacher candidates' experiences in their own K-12 science education likely will impact the beliefs about the use of fictional literature in elementary science instruction they bring with them to a science methods course. However, "whether in the science classroom or in the science teacher education program, how individuals learn from experience remains a poorly understood phenomenon" (Russell & Martin, 2014, p. 871), making this study relevant.

Additional research demonstrates that effective instruction during university level methods courses may positively alter those pre-established notions about teaching science at the elementary level (Kazempour, 2014; Skamp & Mueller, 2001; Ucar, 2012). To maximize the impact a methods instructor may have, s/he should utilize the constructivist framework, which entails understanding his/her students' science backgrounds and using that to aid students in constructing new learning about effective science instruction. Fitting with the topic of this study, "Contemporary learning theories in both science and reading follow a constructivist view" (Contant et al., 2014, p. 235). According to Bryan (2003), "If gains are to be made in terms of reforming science teaching, teacher educators need to tailor instruction to address the existing conceptions of those who are expected to enact the changes" (p. 860). Ledoux and McHenry (2004) identified the constructivist approach as one that operates with a "focus on helping [students] form and develop conceptual models that will function as their own coding systems for the to-be-known world" (p. 387). This study sought examine the perceptions of teacher candidates who have yet to enter the world of teaching, but who have the potential to change their beliefs and practice to better meet the needs of their future students. Therefore, a constructivist approach was appropriate.

III. METHODOLOGY

> Subjectivity is everywhere, from the loftiest philosophizing and diplomatic negotiation to the street talk of the juvenile gang and the self-talk of the daydreamer, and it is the purpose of Q methodology to enable the person to represent his or her vantage point for the purposes of holding it constant for inspection and comparison (Brown, 1997, p. 2).

Methodology

To understand the perceptions held by the TCs regarding the integration of fictional literature into elementary science instruction, I used the Q methodology approach (Brown, 1980, 1993; Watts & Stenner, 2012), as well as conducted two focus groups (Lichtman, 2009) to follow up on and further explore the participants' thoughts. I chose Q methodology because it is designed to capture personal beliefs (Barnes at al., 2015), making it a useful methodology to study perceptions. In Q methodology, "the entirety of a person's views regarding a topic is compared to other participants' view[s] on the same topic, thus correlating views instead of statements" (Barnes et al., 2015, p. 142). This methodology requires participants to prioritize their beliefs by sorting a set of self-referential statements (Barnes et al., 2015). While there are some quantitative components such as analyzing the data using correlation, it is qualitative in nature because "it produces rich data, with meaning attributed to statements by participants in the Q sorting process, so that differences between the participants' subjective meaning and understanding becomes the focus" (Simons, 2013, p. 28). Additionally, in Maxwell's (2010) view, "there are legitimate and valuable uses of numbers even in purely qualitative research, and [he does not] see the distinction between numerical and verbal data as a useful way of distinguishing between qualitative and quantitative research (p. 476).

Q Methodology: Origins, Advantages, and Disadvantages

In 1935, the psychologist William Stephenson wrote a letter to the journal *Nature* in which he outlined his ideas for Q methodology (Brown 1996; Simons, 2013; Watts & Stenner, 2012). Over the course of the next few years, he published several academic papers in which he expanded on the basic principles outlined in his original letter (Watts & Stenner, 2012). Stephenson primarily was interested in finding a way to explore and understand individuals' subjectivity in a wide variety of situations (Brown, 1993, 1996; Simons, 2013). Q methodology fell out of favor for many years but, in the last several decades, has seen an increase in use across various fields of academic study (Cross, 2005; Watts & Stenner, 2012).

As a research method, Q methodology is a combination of both qualitative and quantitative methods. It is qualitative because it collects self-referent subjective opinions during the Q sort process, and interviews may be conducted afterwards to encourage participants to expand on those opinions. According to Brown (1993),

> The statements are matters of opinion only (not fact), and the fact that the Q sorter is ranking the statements from his or her own point of view is what brings subjectivity into the picture. There is obviously no right or wrong way to provide 'my point of view' about anything…" (pp. 94-95)

Brown (1996) asserted that Q methodology catches the attention of qualitative researchers because it examines "life as lived from the standpoint of the person living it that is typically passed over by quantitative procedures" (p. 561). On the quantitative side, a complete Q methodology study employs correlation and factor analysis to identify clusters of shared subjective opinions. The results of a Q methodology study can be used to describe a set of viewpoints and can be very helpful in exploring sentiments, tastes, preferences, and opinions (Brown, 1993, 1996; van Exel, 2005). Researchers familiar with Q methodology have described it as "qualiquantilogical" (Simons, 2013; Stenner & Stainton-Rogers, 2004; Watts & Stenner, 2005) because of its use of both research methodologies.

Maxwell (2010) identified several advantages of incorporating quantitative data into a qualitative study. The first is that "Providing numerical data about the distribution of observations, or the number of instances of a particular type of event or statement, helps to deal with potential challenges to these conclusions" (p. 478). Including this data about the placement of the participants' statements supports the interpretations a researcher makes in a Q study. Secondly, "quantitative data can help you to identify patterns that are not apparent simply from the unquantitized qualitative data" (p. 479), such as patterns in statements with which participants most strongly agreed or disagreed. Thirdly, "quantitative data help you to adequately present evidence for your interpretations and to counter claims that you have simply cherrypicked your data for instances that support these interpretations" (p. 479).

Q methodology is suitable for exploring issues in which participants may have diverse points of view, because it focuses on the variety of accounts people construct about an issue (Cross, 2005). According to Simons (2013), a distinct advantage of using Q methodology as a research method is that:

> Q sorting gives participants significant control in deciding what it is about an issue or phenomenon that is important to them. The participants use their statements to construct their own versions of their subjectivity rather than relying completely on the interpretive skills of the researcher, so that meaning is only attributed to an item by the person sorting the statements at the point of sorting and in relation to the other items. (p. 31)

This allows for the meaning to be derived directly from the participants, rather than solely from the analytical skills of the researcher, though there is still some interpretation of the results. Stephenson, the originator of Q methodology, and Brown, who continued and expanded on his work, posited that this methodology allows researchers to categorize and objectively compare subjective viewpoints (Simons, 2013), an aspect of research often overlooked when using quantitative methods (Brown, 1996).

There are some additional advantages to using Q methodology for this study. According to Wright (2013), "Since Q studies work on small samples, and yet still derive rich data, it appears an ideal time and cost-effective addition to the arsenal of methods that researchers can use to understand the subjectivities of groups of students" (p. 157), which is what I attempted to do in this study. Expanding on this notion that Q Methodology is useful with students, Wright (2009) listed additional benefits: 1. "sorts take less time than a formal interview, such that they can be done many at a time," 2. "sorts can be done as a part of a classroom experience" (p. 157). These two components were significant in my study since the Q sort was done as an in-class activity.

Though minimal, there are some drawbacks to Q methodology as well. The development of the concourse, done by the researcher prior to the Q sort, can be time consuming. Brown (1993) identified the concourse as “the very stuff of life” since it is comprised of the totality of what is said about the research question. Simons (2013) noted that it can be difficult for the researcher to determine when the concourse is complete because there is always something else that potentially could be said or written about the topic. The complete and accurate development of the concourse is essential, however, because “the quality of the concourse will determine the quality and reliability of the findings of the Q sort and the identification of the resulting factors” (p. 32). Statements from the concourse are culled for use in the Q sort process and again, a certain degree of skill is required by the researcher. The researcher must be able to narrow down the statements in the concourse to a manageable number for participants to sort. Studies have used as few as 18 to as many as 140, though sorting 140 statements is a lengthy process and might reduce participant involvement and completion of the Q sort (Simons, 2013). For the researcher, “distinguishing the statements so that there is enough – but not too much – distinction between each statement can be challenging” (p. 32). The final set of statements selected for the Q sort should encourage the participants to think, but should not confuse them (Simons, 2013).

The Structure of Q Methodology

Q methodology involves the following stages (Brown, 1980, 1993; Simons, 2013; van Exel, 2005; Watts & Stenner, 2012):

- identifying a research question
- identifying participants
- developing the concourse
- selecting statements suitable for the Q sort

- administering the Q sort to participants
- collecting post-sorting information
- analyzing the factors
- interpreting the factors

In the subsequent sections, I provided an overview of each stage of Q methodology, and described what each stage looked like within the context of this research study.

Research question. According to Watts and Stenner (2012), Q methodological research questions should have a fairly strict and narrow focus since a Q study is used to explore the specific viewpoints of people or groups of people. In developing the research question, the researcher should retain a clear focus and not try to cover too much information in a single study, or both the researcher and the participants might get lost (Watts & Stenner, 2012). Simons (2013) echoed this sentiment, stating that "the initial research question must be straightforward and clearly stated" (p. 29) in order to develop a complete concept for the study.

To narrow the scope of the study, research questions should be categorized as representations of a subject matter, understandings of it, or conduct in relation to it (Watts & Stenner, 2012). Additional categorizations include causes and reasons for something, definitions, and reactions or responses to a phenomenon. If the focus of a study is on *representations*, participants may reflect on how an issue or topic is understood within a particular group or setting. Studies that invite participants to reflect on their *understandings* have a more personal, individual focus. Studies focused on *conduct* invite participants to address their responses to a subject matter, such as defining what could be done about a particular situation or describing appropriate reactions.

The purpose of my dissertation study was to examine the thoughts, feelings, and beliefs of teacher candidates about the integration of fictional literature in elementary science instruction. I asked participants to explore their understanding from an individual point of view rather than from a group perspective, which situated this study in the *understandings* category (Watts & Stenner, 2012). The research question that guided this study was:

> What are the thoughts, feelings, and beliefs held by teacher candidates regarding the integration of fictional literature in elementary science instruction?

Sub-questions included:

1) What benefits do teacher candidates perceive in integrating language arts/fictional literature and science?

2) What disadvantages do teacher candidates perceive in integrating language arts/fictional literature and science?

3) What impact, if any, did the teacher candidates' own experiences in elementary science have on their thoughts?

Research questions focused on participants' understandings ask participants to explore what the topic means to them "in relation to [their] own life experience" (Watts & Stenner, 2012, p. 55), so the exploration of the TCs' backgrounds was an important component of the study. As noted by Watts and Stenner (2012) and Simons (2013), the research question should be straightforward and clearly worded to simplify the process for the participants. Therefore, the research question presented to the participants during the Q sort process was: What role, if any, should fictional literature play in elementary science instruction?

Identifying participants. When thinking about the participants for a study, two things must be considered: the quality and the quantity (Watts & Stenner, 2012). Because Q methodology attempts to discover relevant viewpoints, finding participants who have clear views on a topic and, more importantly, whose viewpoints matter in relation to the topic, is of utmost importance (Watts & Stenner, 2012). Selecting participants solely because they are easily accessible will not yield a relevant set of data. According to Watts and Stenner (2012), "you can legitimately select a participant if you think them likely to express a particularly interesting or pivotal point of view" (p. 71).

In terms of the quantity of participants, or P set, "since the issue of Q methodology is the nature of the [statements] and the extent to which they are similar or dissimilar, the issue of large numbers, so fundamental to most social research, is rendered relatively unimportant" (Brown, 1993, p. 94). Because Q methodology generally aims to identify a set of viewpoints, and then understand and compare them, a large sample size is not required. In fact, Watts and Stenner (2012) assert this can be done with "very few participants" (p. 72) or even a single individual.

Because my study sought to examine the perceptions of TCs regarding the integration of fictional literature into elementary science instruction, I drew on two sections of students enrolled in CI (Curriculum & Instruction) 4355, Science in Elementary Education, as my participants. I began teaching this course at the university in question during the first summer session in 2015, and continued every semester since then. Though this may be considered an opportunity sample since the students are easily accessible to me, these students' perspectives are extremely relevant to the research question, and therefore were an appropriate choice for inclusion in this study. Watts and

Stenner (2012) noted, “the *right* participants will always be a function of the research question you’re trying to answer” (p. 71); students enrolled in CI 4355 are the right participants. I chose to focus on TCs’ perspectives rather than practicing teachers primarily because this study is intended to inform the practice of science methods instructors, who may yet have an impact on TCs’ practices once they enter the teaching profession (Donovan & Smolkin, 2001; Kazempour, 2014; Skamp & Mueller, 2001; Ucar, 2012). Though practicing teachers may also change their beliefs, they are less likely to be influenced by instructors at four-year universities.

When considering the use of my own students as research participants, several faculty members were consulted to determine if this was feasible; one of the faculty members contacted is the Chair of the Institutional Review Board (IRB) at said university, who indicated it was permissible. Because Wright (2009) asserted that Q sorts can be done as a part of a classroom experience, I used the Q sort as an in-class activity to introduce our studies of interdisciplinary work in elementary science. This took place in the third week of a four-and-a-half-week class, before we discussed the integration of ELA and science. Because the science methods course is considered a flex course, or one that students can take wherever it fits in their teacher preparation coursework, some students may have received instruction in interdisciplinary work in other courses prior to taking mine. Once students completed the activity, I left the room and an individual unconnected to the study entered. Using a provided script, this individual informed the students that the Q sort was both part of their classwork and potentially a part of my dissertation study if they granted permission for its use. Students also were informed that they would not be penalized in any way for not participating in the research and that the activity was in no way connected to a grade for the course, as instructed by the IRB recommendations. The students who did not want to be included in the study were asked to keep their distribution sheets. Those that agreed to participate were provided a consent form (see Appendix A) and a sheet in which they provided some basic demographic information as well as a brief description of their own experiences in elementary science (see Appendix B). Additionally, students were asked if they would be willing to participate in a focus group that would last no longer than an hour to further explore their thoughts on the topic of the use of fictional literature in elementary science.

Typically, the number of participants is less than the number of items in the card sort that the participants will be doing to explore their thoughts on the subject (Watts & Stenner, 2012; Wright, 2013). van Exel (2005) recommended using four to five people to define their viewpoints. Summer sections of CI 4355 tend to fill up quickly, and both sections I taught were near capacity. One section had 25 students, the maximum, and the other had 20. In the first section, 20 students consented to participating in the study, and, in the other, 18 students agreed to participate. I included the basic Q sort results for all of the students who voluntarily agreed to participate in the study in this dissertation. However, following van Exel's guidelines (2005), I selected a limited number of students from each section of the course and conducted two focus groups to further explore their viewpoints. In the first section, three students volunteered to participate in the focus group, although only two showed up at the appointed time. In the second section, seven students volunteered. I put their names in a pile and randomly selected five students to participate. The data from the focus groups is reported in more detail in the results chapters of this study.

Concourse development. According to Brown (1993), the concourse is "the flow of communicability surrounding any topic" (p. 94). Though van Exel (2005) noted the concourse should contain "all the relevant aspects of all the discourses" (p. 4) surrounding a topic, Simons (2013) cautioned that this process can be extremely time consuming, and advised stopping once the researcher feels the saturation point has been reached. In either case, the concourse might be developed in multiple ways. Many researchers choose to use interviews (Brown, 1993; Simons, 2013; van Exel, 2005) to develop statements for the concourse. In addition to interviews, a verbal concourse may be obtained from literature, newspapers, novels, media reports, or participant observation as well (van Exel, 2005). However, concourses are not restricted to words or statements. Brown (1993) noted that concourses might include paintings, photographs, musical selections, pieces of art, or cartoons. In fact, any set of items that potentially can be rank-ordered from a first person perspective could comprise a concourse; there are many different possibilities (Watts & Stenner, 2012).

In this study, I created the statements for the Q methodology concourse from a mix of the participants' responses to survey questions (see Appendix C) about integrating literature into science instruction as well as existing scholarly literature about the topic. The survey was sent to the participants via Google Forms more than one week before the day on which they completed the Q sort in class, and students were asked to respond within two days. Watts and Stenner (2012) suggested, "it is sensible and commonplace to begin item sampling via extensive reference to the academic literature" (p. 60). Therefore, because the concourse development was a time consuming process, I pulled statements from my review of the literature to include in my concourse prior to administering the survey so that my concourse was partially completed ahead of time. As I collected the statements, I made notes about how the statements could potentially be grouped by theme. Some of the initial themes that emerged were: fictional literature as a tool to support science instruction, stimulating imagination, shared skills/strategies/processes, benefits, and disadvantages. After receiving the surveys, I organized the answers into tables and reviewed the students' responses. I used the students' responses to supplement the statements from the literature I had already collected. Additional themes that emerged were: TCs' backgrounds, connection to TEKS, and classroom use. The final result was a saturated set of "declarative sentences, opinions, attitudes, or other texts about which a subject will make a judgment" (Serrano, 2014, p. 40). Salient points under each theme were flagged, and included in a list of potential Q set statements.

Selecting statements for the Q set. The Q set (or Q sample) is a subset of statements taken from the concourse, which are representative of the larger concourse. According to Brown (1993), "the main goal in selecting a Q sample is to provide a miniature which, in major respects, contains the comprehensiveness of the larger process being modeled" (p. 99). When selecting statements for the final Q set, researchers should select statements that widely differ from each other to make the Q set broadly representative (van Exel, 2005; Watts & Stenner, 2012). According to Watts and Stenner (2012),

> A suitably balanced Q set will come very close to capturing the full gamut of possible opinion and perspective in relation to your research question. This needn't imply, as often seems to be concluded, that half of the items in the Q set

> have to be positive (or pro) responses to the research question and half negative (or anti). It might mean that in some contexts and in relations to some research questions, but balance always has a wider connotation than mere positives and negatives. We are ensuring that our Q set does not appear to be *value-laden* or *biased* towards some particular viewpoint or opinion. It is imperative that all the participants can respond effectively to the research question, in any way that they want, using the items provided… [without feeling] limited, restricted, or frustrated by failures of balance and coverage. (p. 58)

Because it is important to ensure that participants feel they are able to successfully express their viewpoints, carefully constructing the Q set is essential. Watts and Stenner (2012) noted that Stephenson, the originator of Q methodology, is fairly vague about the design of his Q sets. For example, Stephenson reported that "it was a straightforward matter to collect 100 statements from Holton's article," for his concourse, and that "a Q-sample n = 40 was composed" (Stephenson, 1987, p. 531). Ambiguous descriptions such as these leave the methodology open to criticism, so a careful description of the process used to cull statements for the Q sort is a necessary part of the research design.

There are two basic ways to construct a Q set: structured and unstructured (Watts & Stenner, 2012). In the structured method, the researcher may use existing theory and research, or simply observation, to break down the concourse into a series of themes or issues (Watts & Stenner, 2012). For example, the researcher might identify seven themes, then select six or seven items from the concourse that represent each theme, for a total of 42 or 49 items for the Q sort. The appeal of this is that "a clear sense of system and rigidity is brought to the sampling process…and claims about the representative nature of the item sample are undoubtedly buffered by the application of defined quota sampling principles" (p. 59). A second approach to the selection of the Q set is more fluid. Although the process still likely begins with the identification of key themes or issues surrounding the topic, "this is simply done in the service of understanding the subject matter as a whole, rather than for purposes of subsequent dissection" (p. 60). The aim of unstructured Q set selection is to pull a representative sample from the whole concourse, rather than try to adhere to some quota from predefined themes. One advantage of this approach is that it gives the researcher more flexibility in the construction process (Watts & Stenner, 2012). A drawback, however, is that a great degree of attention to detail is required to ensure that the final Q set is representative of the entirety of the concourse (Watts & Stenner, 2012).

There are several considerations to make when selecting statements to include in the Q set. The first is that items containing technical or complicated language should be avoided, unless the participants have a particular expertise in a relevant field (Watts & Stenner, 2012). The second is that "double-barrelled [sic] items, containing two or more propositions and/or qualifications of various kinds, can also be problematic" (p. 62). For example, a statement such as *Using fictional literature in elementary science can be challenging but instructional* would be difficult to sort if a participant agrees with the challenging part but disagrees with the instructional part. Similarly, a statement such as *I will use fictional literature regularly when I teach science because students enjoy stories more than non-fiction* also presents some challenges. Though participants might be able to sort this statement into agree or disagree, it would be difficult for the researcher to interpret why participants disagreed with it because it could mean: (a) they might only use fictional literature occasionally; (b) they never plan on using fictional literature; or (c) they will use fictional literature regularly but for reasons other than students enjoying stories more than non-fiction. The third consideration to make when selecting statements is to avoid ones that are expressed negatively. For example, a participant would have to disagree with a statement such as *I do not believe fictional literature is useful in science instruction* if their belief is that fictional literature is useful. The double negative can be confusing for participants, so statements should be worded so that they are straightforward (Watts & Stenner, 2012).

When selecting the number of statements to use in the study, I considered the subject matter and the types of views explored in the study, among other factors. I made an effort to balance the desire for more statements to maximize the level of detail of my analysis with the incorporation of too many statements, which could have caused confusion or disinterest in the participants if the task of sorting the statements became burdensome. Watts and Stenner (2012) noted that a final Q set of between 40 to 80 items is the standard, though Simons (2013) reported studies have ranged anywhere from 18 to 140 statements. I selected statements from my concourse to use as my final Q set according to the guidelines established by Watts and Stenner (2012). This gave me enough material so that a balanced, representative view of the concourse was presented to the participants without being too overwhelming during the sorting process.

I used the unstructured approach (Watts & Stenner, 2012) to select statements for the Q sort. Though I identified themes that emerged from the concourse, as in the structured approach, I did not want to be restricted by finding a certain number of statements to fit each theme, as this would not yield a complete representative sample.

As Watts and Stenner recommended (2012), I avoided selecting any items with two or more propositions or with double negatives so as to simplify the process for the participants. Statements that were similar in nature were combined, or the statement that was clearer was chosen for final inclusion in the Q set. Some statements were reworded slightly. Once I had a draft of the final set of statements, it was shared with an outside reviewer, and the feedback I received was incorporated into the final set. Five statements were deleted because they were redundant, and three more were reworded to make them more straightforward. A few statements that were similar in nature were included to see if participants agreed or disagreed with both. The final result was a Q set comprised of 43 statements, as seen in Table 3-1, organized by theme.

Table 3-1: Q set statements organized by theme

TCs' Backgrounds	I have a limited background in using fictional literature to teach science
	Teachers used fictional literature in my science classes when I was in elementary school
Shared Skills, Strategies, and Processes	Fictional literature and science both encourage students to think critically
	Using fictional literature will increase students' science comprehension skills
	Using fictional literature encourages students to make predictions, which is an important skill in science
Fictional Lit. as a Tool to Support Science Instruction	Fictional literature helps make a difficult science concept easier to understand
	Fictional literature uses science vocabulary that is more suited for children than non-fiction
	There is a lack of understanding about how fictional literature can be used to support science instruction
	Using fictional literature helps children get a better understanding of the science content
	Using fictional literature will help students connect to the science content more easily
	Using fictional literature helps students access their prior knowledge
	I would like to know more about how to incorporate fictional literature into science teaching/learning
	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts

	Using fictional literature during science instruction will help elaborate on the concepts being taught
	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts
	Fictional literature will help students acquire scientific habits of mind
Connection to TEKS	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
	Fictional literature helps teach the science TEKS
Benefits	Fictional literature is beneficial in getting students excited about science
	Using fictional literature will make science more relatable to students
	Fictional literature can be used to make science more approachable to youth
	Fictional literature stimulates students' imagination and curiosity about science
	I think that using fictional literature to teach science will get the children more engaged and interested in science
	Fictional literature has the potential to increase both students' science knowledge and reading achievement
	Fictional literature will help stimulate students' imagination about science
	Using fictional literature broadens the range of science content to which students are exposed
Disadvantages	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning
	Fictional literature may lead to misconceptions about science if it adds too much fantasy
	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content
	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
	The accuracy of science content suffers in fictional literature
	Students will have a difficult time transferring science information from a fictional setting to a real-world one
Classroom Use	Fictional literature should be used to teach science only if it includes actual facts with the story
	In order to use fictional literature to teach science, the teacher must know how to select books carefully
	Fictional literature should be used to teach science because all subject areas are linked
	Reading books is an important part of science instruction
	Fictional literature should be used during science instruction

	Fictional literature should not be used during instruction because science is based on factual information
	Non-fictional literature should be used more than fictional literature in science instruction
	There is a time for fictional literature in elementary instruction, just not in science
	Fictional literature should be used more as a teaching tool in science
	Fictional literature is underutilized in science instruction
	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science

I randomly assigned a number to each statement for identification purposes (Brown, 1993; van Exel, 2005) to complete the Q set. The numbers were not consecutive so as to minimize potential bias, as participants might have felt a statement with the number one was more significant than a higher number. Lastly, I printed each statement on separate cards so that participants had their own set of cards for the sorting process. Watts and Stenner (2012) noted that the cards should all be the same color so that participants' reactions are a product of the statement on the card and not a reaction to the visual aspects of it. I created 50 identical sets of same colored cards for participants to sort (see Appendix D for one complete set of cards).

Administering the Q sort to participants. One very important consideration during the Q sort is to make the process as simple as possible for participants so that they can focus on the statements rather than the sorting procedure itself. One way researchers can minimize the complexity of the procedure is to carefully consider the type of sorting distribution. The standard choice for Q methodologists is a fixed choice normal distribution or quasi-normal distribution (Figure 3-1), though any relatively symmetrical shape can be used (Simons, 2013; Watts & Stenner, 2012; van Exel, 2005).

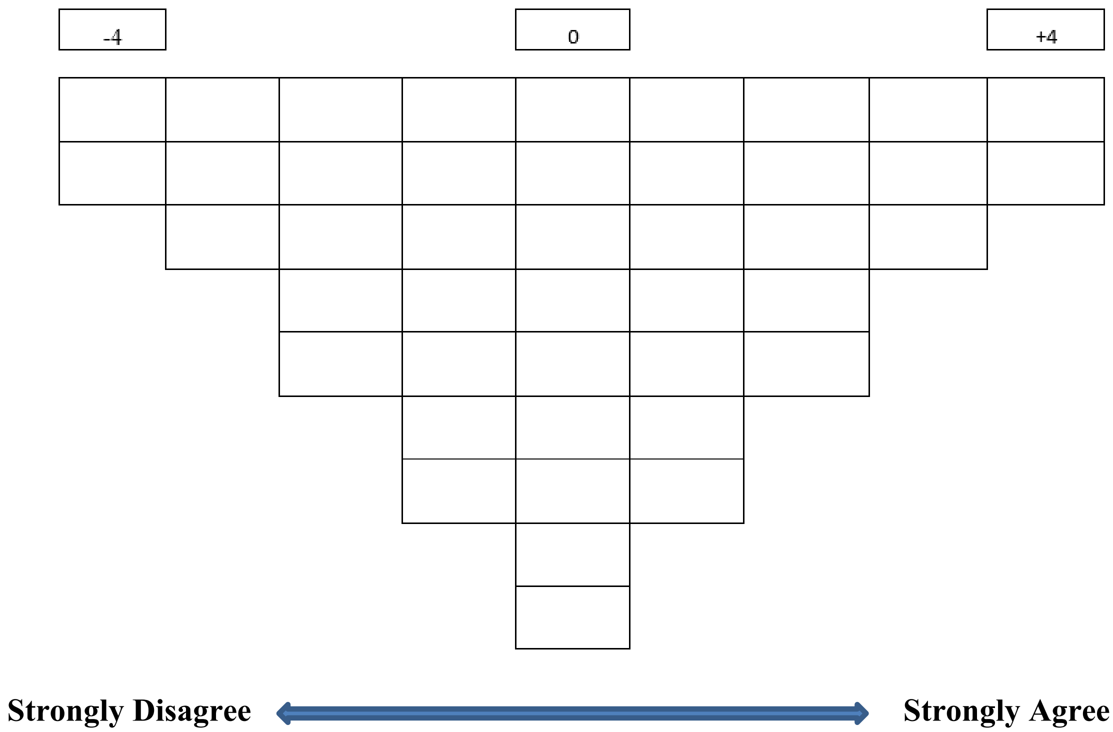

Figure 3-1: Distribution for Q sort

The preferred method for numbering the distribution is to have a positive value at one pole, zero in the center, and a negative value at the other pole (Watts & Stenner, 2012). Some researchers choose to use only positive numbers, such as one through nine, or leave off the numbers altogether to minimize the possibility participants may not want to have a negative association when placing their statements (Watts & Stenner, 2012). The shape of the distribution is also significant. Brown (1980) suggested that if participants are likely to be unfamiliar with the topic or if the topic is complex, a steeper distribution is recommended (Figure 3-1), allowing for a greater number of items to be placed near the middle of the distribution since participants may have more neutral feelings. A shallower distribution should be used when participants are experts in the topic or if the topic is relatively straightforward. A blank copy of the distribution should be provided to participants for means of recording their card sort information. In addition, a set of instructions should be provided to participants so that they can successfully complete the card sort.

Along with administering the Q sort, Watts and Stenner (2012) recommended collecting some basic demographic information such as age and gender; the type and amount of information will vary based on the type of study being conducted. In some cases, more information will be required. The main goal is to "pursue any and all personal information that is likely to influence our participants' viewpoints in some way" (p. 74).

The basic procedure for administering the Q sort is as follows (Brown, 1980, 1993; Simons, 2013; Watts & Stenner, 2012; van Exel, 2005). Upon arrival of the participants, ethical formalities such as signing consent forms should be completed, followed by gathering pre-sort information such as demographic information. A set of randomly numbered cards, each one containing a statement from the Q set, should be given to participants, along with the instructions for completing the Q sort and a blank copy of the distribution sheet. The instructions should include the condition of instruction, which is generally the research question followed by a statement or statements about what the participants will do doing the sort (van Exel, 2005). The participants are instructed to read through all of the statements on the cards carefully, so they get an impression of the range of issues presented. Next, the participants are asked to sort the statements into three basic piles: agree, disagree, or neutral/undecided. The participants will count the number of cards in each pile and record that information on the distribution sheet, making sure the numbers add up to the total number of cards.

Following that, the participants will rank order the statements, starting with the agree pile. They should read through the statements in this pile again and select the two with which they most agree, then write the corresponding numbers in the last two boxes on the right side of the distribution sheet. From the remaining cards in the agree pile, participants should select the next three statements with which they most agree, and write the corresponding numbers in the column adjacent to the first one. This procedure should be repeated until all of the numbers corresponding to statements on the cards from the agree pile are placed on the distribution sheet (Figure 3-3). These steps will be repeated with the disagree pile, followed by the neutral pile, until all of the cards have been accounted for.

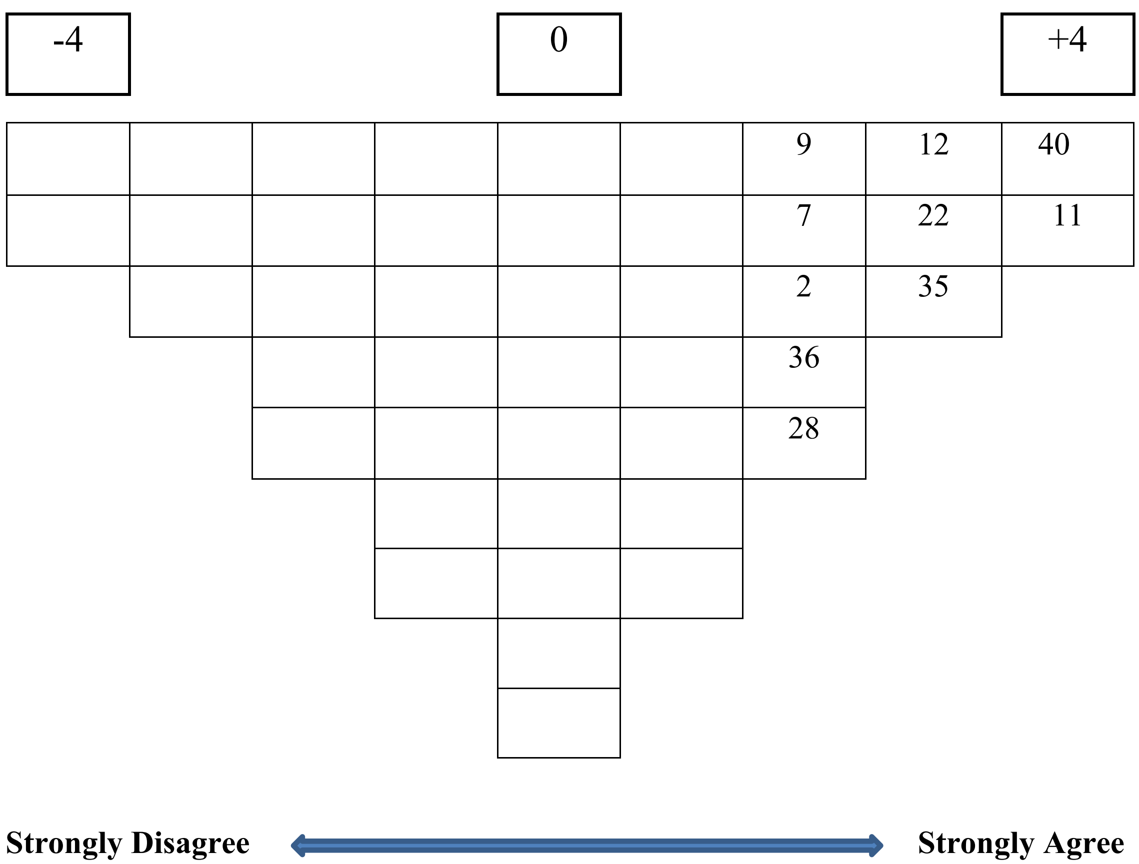

Figure 3-2: Sample distribution sheet partially complete with "agree" statements

I created the distribution sheet (see Appendix E) using a normal and a relatively steep distribution since the participants did not have a great deal of knowledge about the use of fictional literature in elementary science instruction. The distribution sheet ranged in value from -4 to +4, and was marked with strongly disagree positioned under the -4 and strongly agree under the +4. I created a set of instructions (see Appendix F) adapted from van Exel's (2005) guidelines to assist participants with the Q sort process. Participants followed the guidelines outlined on the instruction sheet to complete the card sort. I remained in the room during the card sort to answer any questions participants had about the procedure or statements on the cards.

As recommended by Watts and Stenner (2012) I collected some demographic information from my participants (see Appendix B). The participants were asked to identify their age, race/ethnicity, gender, and progress in the teacher preparation program, as well as describe a little about their experiences in elementary science. As mentioned previously, all students enrolled in two sections of CI 4355 completed the sort as an in-class activity, and were asked permission to use their information in a study after completing the sort. The students who gave permission for their information to be used were given a consent form (see Appendix A) and a demographics information sheet (see Appendix B) to fill out, and students who did not want to participate kept their information.

Collecting post-sort information. Research clearly shows that TCs enrolled in methods courses bring a set of beliefs about science teaching and learning established through their progression of their own experience in elementary science to those courses (Bryan, 2003; Dickson & Kadbey, 2014; Eick & Reed, 2002; Russell & Martin, 2014;

Skamp & Mueller, 2001). While Q methodology is useful to explore those beliefs, simply doing the Q sort alone did not provide data or insight into how those beliefs might have been impacted by the TCs' experiences in elementary science. Watts and Stenner (2012) recommended gathering additional information and participant commentary, stating "this additional data is always a vital means of supporting interpretation" (p. 57). Wright (2013) echoed this sentiment, stating a "post-sort interview is often conducted to establish some qualitative data regarding the reasons behind positioning statements" (p. 155).

To capture this data, I conducted two focus groups comprised of two and five participants respectively, following van Exel's (2005) recommended numbers for a Q methodology study. Focus groups are useful "to obtain in-depth knowledge concerning attitudes, perceptions, beliefs and opinions of individuals" (Then, Rankin, & Ali, 2014, p. 16) regarding a specific topic. According to Lichtman (2009), focus groups are useful because they allow group members to interact and stimulate each other's thinking. Although I am interested in individual perspectives, I chose to conduct focus groups rather than individual interviews for several reasons, outlined in Table 3-2.

Table 3-2: Rationale for conducting a focus group (Lichtman, 2009; Then et al., 2014)
Focus group research can be an instrument used within the context or larger qualitative or mixed-methods studies.
It differs from individual interviews in that participants may feel more free to disclose information freely since it facilitates greater anonymity
Focus groups may decrease bias in individual interviews, as interviewees might try to figure out what type of response the interviewer wants. This is particularly important with my participants because I am the instructor for the course in which they are enrolled.
It allows for individuals to state their opinions, further reflect on their opinions, or change their opinions after listening to other participants.

Hearing what other participants have to say might jog memories. This is particularly important for the question asking participants to describe their experiences in elementary science, since they may have trouble recalling events from that long ago.
Group settings tend to be more relaxed.

Focus group participants were offered a $10.00 gift card to Einstein's to thank them for their time. A focus group protocol was developed (see Appendix G) based on van Exel's (2005) assertion that participants should be asked to elaborate on their points of view, and in particular about why they placed certain statements at the extremes of the continuum on the distribution sheet. The focus groups were semi-structured in nature, meaning I had a general set of questions and format, but varied the questions as the situation demanded (Lichtman, 2009). Appendix G includes a list of the initial questions. The focus groups were audio-recorded, transcribed, and checked for accuracy.

Constructivism vs. Constructionism

Up to this point, the preceding sections describe a traditional, complete Q methodology study, from identifying the research question through collecting post-sort information. The final two components of a Q study are analyzing and interpreting the factors. These two steps are "sometimes referred to as the scientific base of Q" (van Exel, 2005, p. 8), and are described in more detail in the following sections. In essence, the analysis is intended to reveal "the primary ways in which themes are interconnected or related by a group of participants, and show the particular combinations of themes that are preferred by the participants" (Simons, 2013, p. 29). This constructionist perspective shifts the focus "away from personal meanings and knowledge structures toward their social counterparts; the shared viewpoints…that represent the substantive, cumulative, and publicly accessible product of innumerable human selections" (Watts & Stenner, 2012, p. 42). Although I performed a basic analysis of the Q sort data for all participants to examine the shared viewpoints, I also was interested in "the ways in which specific individuals come to interpret and make sense of their physical and social world and the personal viewpoints and knowledge structures that result" (Watts & Stenner, 2012, p. 42), i.e. the constructivist perspective. Therefore, I deviated from the complete detailed factor analysis recommended in a full Q study, and I also chose to focus on the data collected during the focus groups as a way to make sense of individual participants' perspectives.

Analyzing and Interpreting the Data

Q methodology. Data analysis is typically conducted using a variety of different software products, although the most frequently used software is PQMethod, a free program accompanied by an instruction manual (Watts & Stenner, 2012; Wright, 2013). Following the instructions, users input the statements from the Q set along with the results from the card sorts based on the distribution sheet data for each participant. Once the information is entered into the program, correlations are calculated between the sorts (Wright, 2013), which appear under the heading 'Correlation matrix between sorts' (Watts & Stenner, 2012). According to Watts and Stenner (2012), "in Q methodology, correlation provides a measure of the nature and extent of the relationship between any two Q sorts and hence a measure of their similarity or otherwise" (p. 97). In the resulting matrix, scores close to one show sorts that are highly intercorrelated. Low or near zero scores reveal Q sorts that have comparatively little in common with the others (Watts & Stenner, 2012). Once the matrix is assembled, the program will ask for the desired number of factors. Watts and Stenner (2012) recommend one factor for every six Q sorts in the study as a starting point, though Brown (1980) recommended seven factors. The basic purpose of the factor analysis is “to explain as much as [possible] about the relationships that holds between the many Q sorts in the group through the identification of, and by reference to, any sizeable portions of common or *shared* meaning that are present in the data” (p. 98). The factors attempt to capture patterns of similarity in the viewpoints participants expressed during the Q sort process, which leads to “key viewpoints that are held in common within the participant group” (p. 98). This is the extent to which I used Q methodology data analysis procedures via the PQMethod software. For a complete description of the entire process, refer to Brown (1980) and Watts and Stenner (2012).

I used PQMethod for my data analysis. Following the instructions in the manual, I gave my study a title not to exceed 68 characters: TCs’ Perceptions About Fictional Literature and Science. I then entered the number of statements that were in my Q sort: 43. When asked about the parameters on my distribution sheet, I entered -4 and +4, followed by the number of rows that existed for each column on my distribution sheet. Beginning with one Q sort, I entered the statement numbers for each ranking value beginning with the statement numbers under -4 and concluding with the statement numbers under +4.

I performed this process with all seven Q sorts for the focus group, and asked the program to assemble the correlation matrix, “which includes all the Q sorts gathered and hence all the viewpoints [the] participants have produced… to represent or encapsulate 100% of the meaning and variability present in the study” (Watts & Stenner, 2012, p. 98). I followed Watts and Stenner’s (2012) guidelines and instructed the PQMethod program to extract two factors because there were seven participants. These factors indicated the key viewpoints held by the entire focus group participants. These results are in chapter 4. I repeated these steps with the Q sorts for all 38 participants as well, and extracted seven factors because there were 38 participants; the results for the full group of participants is in chapter five. Additionally, in each of the results chapters, I provided an interpretation of each factor following the procedures outlined by Watts and Stenner (2012), which are described in more detail within those chapters.

Focus groups. I used Yin's (2011) five-phase approach to analysis to make sense of the data from the focus groups and better understand the perceptions held by the TCs. According to Yin (2011), phase one involves compiling the data. The second phase is disassembling, or breaking down the data into smaller pieces. During this phase, codes may be assigned to the fragments, though it is not required (Yin, 2011). According to Lichtman (2009), "codes emerge from the data via a process of reading and thinking about the text material" (p. 194). Once all the codes are assigned, the researcher reviews the codes to look for ones that align, which can then be organized into categories. This is Yin's (2011) third phase—reassembling the data. This can be done graphically or by organizing the data into lists or tables. The fourth phase, interpreting, is the process of giving meaning to the reassembled data. Though Yin (2011) acknowledged there is no firm definition of a comprehensive interpretation, he suggested striving for completeness, fairness, empirical accuracy, value-addedness, and credibility. Interpretation may take the form of description, description plus a call for action, or explanation (Yin, 2011), and descriptions "can be presented with varying levels of detail" (p. 213). Description plus a call for action occurs when a study tries to promote some subsequent action in addition to describing the data, as in the case of action research. Explanation can be a part of descriptive interpretation when “the interpretation is dedicated to explaining how or why events came about” (p. 216). According to Yin (2011), “The ideal interpretations will connect the ideas of interest—reflected, for instance, by the relevant literature—with [the] reassembled data” (p. 219). The final stage is the concluding stage, which should conceptualize the significance of the study (Yin, 2011). The five types of conclusions (Yin, 2011) are:

- concluding by calling for new research
- concluding by challenging conventional generalizations
- concluding with new concepts or theories
- concluding by making substantive propositions
- concluding by generalizing to a broader set of situations

In his graphic representation of the five-phase process, Yin (2011) uses a two-way arrow to signify the fluidity of the five-phase process; it does not necessarily progress in a linear fashion.

I compiled the data by collecting the transcripts from the focus groups, the demographic information, and the distribution sheets for all of the participants. I reviewed all three forms of data and assigned codes to smaller fragments of information during the disassembling phase. The codes that emerged were elementary science experience, most agree rationale, most disagree rationale, elementary experiences’ impact on current perspectives, other school science experiences, using fictional literature in science, teacher’s role in using fictional literature, learning styles, balance between fiction and non-fiction, and future needs related to fictional literature and science. After compiling and disassembling the data, I reassembled the data in a list to find relationships between shared viewpoints according to the assigned codes. In the interpreting phase, I analyzed the data to look for emerging patterns, categories, and themes based on my understanding of the data, the research literature, and the research questions. I used description to "derive a deep understanding of the… conditions being studied" (Yin, 2011, p. 213). Keeping the constructivist framework in mind, I examined the data to see if the participants' background experiences in elementary science impacted their views on the role of fictional literature in elementary science instruction. The final step was reporting key findings along with implications and recommendations for future research, and providing concluding remarks.

Validation Strategies

Creswell (2013) defined validation strategies as "strategies [researchers employ] to document the 'accuracy' of their studies" (p. 250). Some of these strategies include member checking (p. 252), triangulation (p. 251), peer review/debriefing (p. 251), rich description (p. 252), and clarifying researcher bias (p. 251).

Member checking. Member checking is considered by Lincoln and Guba (1985) to be "the most critical technique for establishing creditability" (p. 314). In this validation strategy, the researcher should consult with the participants to obtain their views about the findings (Creswell, 2013; Lincoln & Guba, 1985). After I wrote up the description of each participant and their distribution results, I e-mailed each participant's section to him/her individually and asked him/her to respond with comments and feedback to ensure I gave an accurate portrayal of each participant and his/her views. Three of the participants responded, and all three confirmed that the information was correct. I contacted the remaining participants again, but did not receive a response.

Triangulation. Triangulation requires researchers to find evidence to document codes, themes, and/or interpretations from multiple sources of data to corroborate and provide validity to the findings (Creswell, 2013; Lincoln & Guba, 1985). The procedures in Q methodology lend themselves to triangulation, as the participants' responses during the post-sort focus groups supported the data in the factor arrays. When constructing the interpretation, assertions about the positions of the statements, i.e. the strength of the agreement or disagreement, are supported by evidence in the form of the positioning of other statements, as well as comments from the participants themselves (Watts & Stenner, 2012).

Peer review/peer debriefing. This is an external check of the research process (Creswell, 2013; Lincoln & Guba, 1985). The peer reviewer serves as a sounding board for the researcher, "who keeps the researcher honest, [and] asks hard questions about methods, meanings, and interpretations" (Creswell, 2013, p. 251). In this study, my dissertation chair served as my peer reviewer, and we had frequent contact and communication during which she provided me with constructive feedback and encouraged me to clarify and strengthen my work to produce the most cohesive study possible. I also debriefed with an objective peer well-versed in research methodology but unconnected to my study, as Lincoln and Guba (1985) recommended. I chose a classmate to engage in debriefing sessions during my data collection and analysis phases.

Rich description. When done well, rich description "allows the readers to make decisions about transferability because the writer describes in detail the participants or setting under study" (Creswell, 2013, p. 251). The writer should include ample details when describing a person, case, or theme, and "can involve describing from the general ideas to the narrow, interconnecting the details, using strong action verbs, and quotes" (p. 251). In this study, I provided a complete description of each participant in the focus group. I also described each factor that emerged from the analysis of the participants' distributions thoroughly, making connections between the participants using the positioning of the statements as well as their own words to support the interpretations.

Clarifying researcher bias. Creswell (2013) stated it was important for a researcher to state his/her positionality "from the outset of the study" (p. 251). Based on my own experience and research, I am a proponent of using fictional literature during elementary science instruction. In my own teaching career, fictional literature was a very useful tool during science instruction, from using stories to encourage students to engage with the science topics to having students identify scientific content within the books.

Reliability and Validity

Reliability and validity are central concepts in many research methodologies (Watts & Stenner, 2012). According to Nicholas (2011), "In social research, reliability is defined such that the same response will be obtained on repeated attempts of as [sic] test or measure" (p. 1). Validity is affirmed if the study successfully measures what it states that it is measuring (Watts & Stenner, 2012). However, in Q methodology, reliability and validity are discussed less frequently and ascribed less significance than in other methodologies (Watts & Stenner, 2012). One reason for this is that "Repeated administration of a Q sort to a single participant actually tells you more about the reliability, or otherwise, or the participant's viewpoint than it does about the reliability of the method" (p. 51). Another reason is that "there is no outside criterion for a person's own point of view" (Brown, 1980, p. 175), rendering the traditional definition of validity "meaningless" in Q methodology (Watts & Stenner, 2012, p. 51). Even so, "the reliability of Q Methodology has been demonstrated and established by various means over time" (Nicholas, 2011, p. 9).

Dependability

Dependability "occurs when another researcher can follow the decision trail used by the researcher" (Thomas & Magilvy, 2011, p. 153). Tools the researcher uses to establish this trail are: describing the purposes of the study, discussing the participant selection, describing the data collection process, and explaining how the data were interpreted and analyzed. Within this dissertation, I fully described the purpose of this study, which is to determine teacher candidates' thoughts about the use of fictional literature in elementary science. I described the selection of the participants, and explained why teacher candidates were chosen over practicing teachers. I thoroughly described the data collection procedures, from the selection of statements for the Q sort through the administration of the sort and focus groups. Lastly, using Watts and Stenner's (2012) guidelines, I explained how the interpretation of the factors resulting from the analysis was conducted. Together, these components contributed to the dependability of this study.

Limitations

There are several limitations to Q methodology studies that pertain to this one as well. There are questions regarding the reliability of Q studies, though that was addressed in a preceding section. According to Cross (2005), "social science sees no problems with [reliability] as there is no expectation that an individual will express the same views on two separate occasions" (p. 211). Proponents of Q methodology argue that, even with the lack of need for traditional measures of reliability, Q sorts can be replicated with upwards of 80% reliability up to a year later (Brown, 1980; Cross, 2005), and a study by Lincoln (2011) demonstrated reliability between the same Q sort conducted by the same participant in two different classes within a few days of each other.

Another limitation to Q methodology is that constraints are put on the participants in terms of the number of statements provided and the statements are pre-determined which potentially limits the viewpoints that can be expressed (Cross, 2005). One suggestion to reduce this limitation is to conduct interviews or focus groups about the subject matter prior to constructing the Q set, and use statements derived from those to help build the concourse (Cross, 2005). I sent a survey to the participants and used their comments to round out statements I had already culled from the research literature to build the concourse. This does not eliminate this limitation entirely, but it does allow for more participant voice.

Additionally, another limitation is the risk of bias during the interpretation stage (Cross, 2005). To have a complete Q study, a researcher cannot simply present the factors; the interpretation of each is a significant component (Brown, 1993; Cross, 2005; Watts & Stenner, 2012). According to Cross (2005), "the researcher's analytical skills in moving towards hypotheses or propositions about the data [are needed] to take the analysis beyond the most basic descriptive and counting exercise" (p. 211). To gain skill in this area, I analyzed the crib sheet and interpretation provided by Watts and Stenner (2012) for an example factor included in their book, then practiced doing the interpretations myself with the remaining four example factors before conducting the interpretations for my study.

Lastly, Q methodology “relies for its effectiveness on the cooperation and frankness of the respondent” (Cross, 2005, p. 211). For various reasons, participants might give false accounts of their opinions or be influenced by the context of the study. Cross (2011) mentioned “the risk that the respondent will use the instrument to give an account that they think is acceptable to the researcher rather than how they truly feel about an issue” (p. 211). To minimize this possibility, especially in light of the fact that the participants were my students, I did not inform them ahead of time that the Q sort was part of my dissertation study, nor did they know the topic of my dissertation. As far as the students knew when completing the Q sort, it was just an in-class activity to explore their thoughts about using literature in science that they would be discussing with a shoulder partner. Afterwards, the students were informed about my dissertation study and asked if their information could be used in the study. In structuring things this way, the hope was that the students would give their most honest, frank opinions on the topic.

Summary

This chapter provides a description of the procedures guiding the collection and analysis of data for this study, as well as a description of validation strategies and limitations. The methodological procedures were a combination of both Q methodology (Brown, 1980; Watts & Stenner, 2012) and Yin’s five-phases of analysis (2011) as it pertains to the focus group data. By combining approaches and examining all of these data together, a complete picture of TCs’ perceptions regarding the integration of fictional literature into elementary science instruction emerged.

IV. FOCUS GROUP RESULTS AND INTERPRETATION

In chapter 4, the Q methodology results for the participants in the focus groups (n =7) are separated out from the full group of participants (n=38), which are reported in chapter five. There were two focus groups in this study; the first group had two participants and the second group had five. Chapter four also includes demographic information, a detailed description of the participants' own experiences in elementary science, and their rationales for sorting the cards in the manner they did during the Q sort. This chapter contains data that addresses the primary research question—What are the thoughts, feelings, and beliefs held by teacher candidates regarding the integration of fictional literature into elementary science instruction?—as well as the sub-questions: 1) What benefits do teacher candidates perceive in integrating language arts/fictional literature and science? 2) What disadvantages do teacher candidates perceive in integrating language arts/fictional literature and science? 3) What impact, if any, did the teacher candidates' own experiences in elementary science have on their thoughts about using fictional literature as a teaching tool in science?

In this chapter, each focus group participant, identified by a pseudonym of his/her choosing, is provided his/her own section with the details about each participant's background and thoughts about the use of fictional literature as a teaching tool in elementary science. Each participant's Q methodology distribution is also provided, along with the participants' rationales for choosing the statements with which they most agreed and disagreed. Although the statements in the neutral zone of the distribution yield information (to be discussed in chapter five), during the focus groups I chose to hone in on the areas in which the participants had the strongest feelings about fictional literature in science. The Q methodology correlation matrix, factors, arrays, and interpretations are presented at the end of the chapter.

Participants

Participant 1—Erin. Erin is a 21-year-old White female in her senior year of undergraduate work. She is enrolled in a teacher preparation program, and has completed all of the teacher preparation courses other than student teaching. After she graduates, she hopes to teach second, third, or fourth grade, and would like to teach in a self-contained classroom, meaning she would like to teach all of the subjects. In her own words, Erin described her experience in elementary science as "direct instruction, though a couple of my teachers would set up experiments for us to do." Once Erin got to fifth grade, however, she had a teacher "that most of the other teachers in [her] school didn't like because she was super loud… but it was because we were getting to do stuff." Erin discovered a love of science because of that teacher. She recalled thinking, "'Oh, it's not just reading out of a textbook or writing down notes in a journal.'" Science experiments that had been performed prior to her fifth grade year were usually set up by her teacher with students sitting in a circle watching, and the teacher performing the experiment "like she never trusted us enough." In her elementary school, they spent 45 minutes to an hour a day on science.

-4	-3	-2	-1	0	1	2	3	4
24	27	6	14	1	8	11	22	2
38	33	9	18	3	16	13	26	30
	43	15	21	4	23	19	41	
		28	31	5	32	20		
		34	35	7	37	29		
			36	10	39			
			40	12	42			
				17				
				25				

SubjNo: 1 ID: 21WFSA

Figure 4-1: Erin's Q sort distribution results

Figure 4-1 displays Erin's distribution of the 43 statements in the Q sort. The two statements with which she most agreed (column 4) were 2) Fictional literature is beneficial in getting students excited about science, and 30) Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts. Erin chose statement 2 because of her own experiences in science; when teachers would use "different stuff like that, [she] loved it." Although this statement is at the top right of the distribution sheet, it does not necessarily indicate Erin felt more strongly about it than statement 30; the instructions for the Q sort specified that it did not matter which one was on top or bottom, as long as they were the two statements with which participants most agreed. Erin also strongly agreed with statement 30 because "If I can have a book that makes me think of something or if my teacher is reading a book, and it makes me think of something that happened in my life, then I'm just gonna remember it more than if like 'here's a definition.'"

The statements with which Erin most disagreed (-4 column) were 24) Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content, and 38) Students will have a difficult time transferring science information from a fictional setting to a real-world one. Erin "hated everything" about statement 38, because "at that age, [students] still have a huge imagination, and so it's really easy" to maneuver between fantasy and reality. Table 5-1 shows Erin's choices of statements from the -3 and +3 columns as well.

Table 4-1: Erin's selections for -3 and +3

-3 (fairly strongly disagree)	+3 (fairly strongly agree)
27. Fictional literature will create too many misconceptions to make it a useful teaching tool for science 33. Fictional literature should not be used during instruction because science is based on factual information 43. Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science	22. Fictional literature will help stimulate students' imagination about science 26. Using fictional literature will help students connect to the science content more easily 41. Fictional literature should be used more as a teaching tool in science

Erin believes that using stories as a science teaching tool "gets to [students'] level instead of just throwing facts at them. They get the facts with a story that they can relate to and visually see in their heads and grasp onto that real concept instead of just focusing on 'I have to memorize this for my test.'" In her view, stories help students understand science "more naturally than just listing facts in a textbook." She plans on using fictional literature during science instruction once she starts teaching.

Participant 2—Sharon. Sharon is a 22-year-old White female in her senior year of undergraduate work. She is enrolled in a teacher preparation program, and has completed all of the teacher preparation courses other than the field based blocks and student teaching. After she graduates, she hopes to teach fourth or fifth grades, and would like to teach English language arts (ELA) and social studies. Sharon stated that she "love[s] science, but it's something I discovered in my early adult years. I honestly don't remember elementary school." The one thing that stands out to her from that time is building a Rube Goldberg machine, a type of contraption that includes a chain reaction to perform some kind of task, because it was a fun experience. In her view, "you need to fail at things to figure out what works, and I feel like I haven't seen that that much in the classroom." She doesn't recall teachers giving her the freedom to try things and fail. In her experience, elementary science was "black and white."

-4	-3	-2	-1	0	1	2	3	4
15	27	6	3	1	4	2	19	20
43	33	25	5	10	7	9	23	37
	34	28	8	11	18	14	29	
		30	21	12	35	22		
		31	24	13	36	26		
			38	16	39			
			40	17	42			
				32				
				41				

SubjNo: 2 ID: 22WFSA

Figure 4-2: Sharon's Q sort distribution results

Figure 4-2 displays Sharon's distribution of the 43 statements in the Q sort. The two statements with which she most agreed were 20) Fictional literature stimulates students' imagination and curiosity about science, and 37) There is a lack of understanding about how fictional literature can be used to support science instruction. Sharon believes that "books are fun," and teachers can ask interesting questions about stories to get students to start to think about science in different ways. Sharon chose item 37—lack of understanding about how to use fictional literature—because "this is probably one of the first times anyone's ever really opened up the discussion about what fictional literature could do for science." Although books were brought into many of her lessons throughout school, "it's never been actually a question or talked about" in her school experience.

The statements with which Sharon most disagreed were 15) It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction, and 43) Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science. When explaining why she chose item 15, Sharon referenced the project we do in the science methods course during which students select books they think would help teach the science TEKS. She found "a lot of cool books in the library where the TEKS is [sic] basically spelled out in them, so it's super awesome." Rather than stories causing students who dislike language arts to become less interested in science, she felt that students who like science might become more interested in language arts if stories are used as a part of instruction.

Table 4-2: Sharon's selections for -3 and +3

-3 (fairly strongly disagree)	+3 (fairly strongly agree)
27. Fictional literature will create too many misconceptions to make it a useful teaching tool for science	19. I would like to know more about how to incorporate fictional literature into science teaching/learning

33. Fictional literature should not be used during instruction because science is based on factual information 34. There is a time for fictional literature in elementary instruction, just not in science	23. Using fictional literature helps children get a better understanding of the science content 29. Using fictional literature will make science more relatable to students

Table 4-2 shows Sharon's choices of statements from the -3 and +3 columns. Two of the three statements in the -3 column—numbers 27 and 33—are identical to Erin's selections in that column. Sharon believes that using fictional literature "just opens up the kids to feel comfortable with [science] too. It would be easier to involve [kids] if it's like a fun book—like fun characters that they can relate to." Although she enjoys non-fiction, she finds that sometimes she will "read" the nonfiction for extended period of time without knowing what she read because "some of those are just awful." She feels like fictional literature has the potential to capture students' interest more than non-fiction, however she stated that a negative "could be the misconceptions that the students might have, like mice aren't recycling." Sharon intends to incorporate fictional literature into her science instruction when she begins teaching.

Participant 3—Juniper. Juniper is a 23-year-old Hispanic female in her senior year of undergraduate work. She is enrolled in a teacher preparation program, and has completed all of the teacher preparation courses other than student teaching. She is certified for special education. After she graduates, she hopes to teach first, second, or third grade, and would like to teach in a self-contained classroom. Like Sharon, Juniper stated that, “it’s kind of hard for me to remember my experiences in science,” though she did recall that, “it was mainly teacher instruction” along with working in workbooks. In addition to the direct instruction by the teacher, she remembered there was “some literature here and there, mixed in with journaling and an emphasis on scientific theory” during elementary science lessons. The overemphasis on science instruction being teacher led brought her to “the point where [she] didn’t have a want to learn science until middle school.” She remembered doing science every day for about 35 minutes, although she stated her educational experience in kindergarten through second grades was more focused on ELA and math because she was in a bilingual classroom. Outside of the regular classroom setting in elementary school, she was in the Young Astronauts program, where she got to do extra science projects like make Alka-Seltzer rockets, and the Gifted and Talented (GT) program.

-4	-3	-2	-1	0	1	2	3	4
33	16	6	1	2	4	10	7	11
34	27	24	3	5	9	12	23	14
	38	28	8	22	17	13	26	
		37	15	25	18	29		
		43	19	30	20	39		
			21	32	41			
			31	35	42			
				36				
				40				

SubjNo: 3 ID: 23HFSA

Figure 4-3: Juniper’s Q sort distribution results

Figure 4-3 displays Juniper’s distribution of the 43 statements in the Q sort. The two statements with which she most agreed were 11) I think that using fictional literature to teach science will get the children more engaged and interested in science, and 14) Fictional literature uses science vocabulary that is more suited for children than non-fiction. During the focus group, Juniper pointed out that her choice of statement 11 is very similar to one of Erin’s selections. She selected this one because she feels that today's students have so much going on that "you really need something that will pull them into a lesson." Upon thinking about how vocabulary is presented in fiction versus non-fiction books, Juniper stated,

> The words are the same, but they're used in different contexts. If you're in a textbook, and you see a word you don't know, it'll give you the definition, and you're still stuck. It's just gonna keep going. Whereas in fictional literature, you'll have pictures or it'll be involved in the story so you get a better concept of it.

The statements with which Juniper most disagreed were 33) Fictional literature should not be used during instruction because science is based on factual information, and 34) There is a time for fictional literature in elementary instruction, just not in science. Here reasons for selecting these two statements were very similar; she "feel[s] like you can learn a lot from fictional literature even if it's not just fact, fact, fact, fact, fact." The idea that someone might believe fictional literature does not belong in science instruction is "mind blowing" to her.

Table 4-3: Juniper's selections for -3 and +3

-3 (fairly strongly disagree)	+3 (fairly strongly agree)
16. Fictional literature should be used to teach science only if it includes actual facts with the story	7. Fictional literature can be used to make science more approachable to youth

27. Fictional literature will create too many misconceptions to make it a useful teaching tool for science	23. Using fictional literature helps children get a better understanding of the science content
38. Students will have a difficult time transferring science information from a fictional setting to a real-world one	26. Using fictional literature will help students connect to the science content more easily

Table 4-3 shows Juniper's choices of statements from the -3 and +3 columns. Several other participants made similar selections. Erin and Sharon placed statement 27 in the -3 column as well. Erin placed statement 26 in the +3 column, and Sharon placed statement 23 in this column. Juniper believes that fictional literature makes science more memorable, and she intends to use it during science when she begins teaching. She recalled listening to and learning about weather during science when she was younger, and she still thinks about pea soup when she thinks about fog because of *Cloudy with a Chance of Meatballs*. Like Sharon, Juniper feels that there is a possibility that students could develop misconceptions about science concepts through the use of fictional literature, and she believes that "teachers should be educated more on addressing misconceptions."

Participant 4—Spenrico. Spenrico is a 23-year-old White male in his senior year of undergraduate work. He is enrolled in a teacher preparation program, and has completed most of his teacher preparation courses other than student teaching. After he graduates, he would like to teach sixth, seventh, or eighth grades, and he would like to teach all subjects. Spenrico "enjoyed science" growing up, but it wasn't his favorite subject. He identified field trips as being the most memorable moments in elementary science.

-4	-3	-2	-1	0	1	2	3	4
27	6	5	3	2	1	4	18	7
43	34	14	12	10	9	8	20	19
	38	24	15	11	22	29	37	
		33	16	13	26	30		
		40	17	21	28	35		
			31	23	41			
			39	25	42			
				32				
				36				

SubjNo: 4 ID: 23WMSM

Figure 4-4: Spenrico's Q sort distribution results

Figure 4-4 displays Spenrico's distribution of the 43 statements in the Q sort. The two statements with which he most agreed were 7) Fictional literature can be used to make science more approachable to youth, and 19) I would like to know more about how to incorporate fictional literature into science teaching/learning. He feels that science can be an intimidating subject for some students, and "they won't even really take the time to even see if they can engage with it if it's not approachable."

Spenrico placed statement 27—Fictional literature will create too many misconceptions to make it a useful teaching tool for science—in the most disagree column. Similarly to Juniper, Spenrico believed that it is a teacher's responsibility to monitor and clarify misconceptions their students may be developing. He also disagreed most with statement 43) Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science. He does not believe "there's a correlation between if you don't like a book, you're gonna all of a sudden dislike science." Sharon also placed statement 43 in the most disagree column.

Table 4-4: Spenrico's selections for -3 and +3

-3 (fairly strongly disagree)	+3 (fairly strongly agree)
6. When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning 34. There is a time for fictional literature in elementary instruction, just not in science 38. Students will have a difficult time transferring science information from a fictional setting to a real-world one	18. Fictional literature has the potential to increase both students' science knowledge and reading achievement 20. Fictional literature stimulates students' imagination and curiosity about science 37. There is a lack of understanding about how fictional literature can be used to support science instruction

Table 4-4 shows Spenrico's selection of statements from the -3 and +3 columns. Juniper placed statement 38 in the -3 column as well. Overall, Spenrico has a positive view about incorporating fictional literature into science instruction, and he plans on using it once he begins teaching. By "breaking [information] down, putting it in a fictional form can help to focus in on certain details or certain facts and make those approachable or in a manner that engages kids," making it a useful teaching tool.

Participant 5—Tonya. Tonya is a 24-year-old Hispanic female in her senior year of undergraduate work. She is enrolled in a teacher preparation program, and has completed all of the teacher preparation courses other than student teaching. After she graduates, she would like to teach third grade or higher, and hopes to teach a combination of ELA and social studies. Tonya described her experience in elementary science as a lot of book work; she does not remember doing labs, though she does recollect working with a bean plant. Because her experience "was not enjoyable," she would "like to learn more about science teaching [for] elementary students" so that she can "teach [her] students to love and enjoy science."

-4	-3	-2	-1	0	1	2	3	4
24	26	2	7	1	20	13	3	22
28	33	11	9	5	30	18	4	25
	43	16	12	6	35	19	42	
		27	17	8	36	23		
		34	21	10	37	40		
			29	14	39			
			31	15	41			
				32				
				38				

SubjNo: 5 ID: 24HFSA

Figure 4-5: Tonya's Q sort distribution results

Figure 4-5 displays Tonya's distribution of the 43 statements in the Q sort. Tonya agreed with 22—Fictional literature will help stimulate students' imagination about science—because "when they're little, they are all like imagination and stuff like that, and that's when you wanna spark them." Tonya also agreed with statement 25—Using fictional literature helps students access their prior knowledge. In reflecting on this statement, Tonya talked about how all students learn differently, so the teacher needs to help them connect to the material. She believes that fictional literature could "give them the extra, little piece that they need." Textbooks are one tool for teaching science, "but when you pull in fictional literature, it's like all different types of stories."

The items with which Tonya most disagreed were 24) Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content, and 28) Non-fictional literature should be used more than fictional literature in science instruction. Both Tonya and Erin placed statement 24 in the most disagree column. Tonya's own learning preferences influenced her choice of statement 28, since "non-fictional literature is what I don't wanna read. I don't wanna read this long page with a big, old paragraph."

Table 4-5: Tonya's selections for -3 and +3

-3 (fairly strongly disagree)	+3 (fairly strongly agree)
26. Using fictional literature will help students connect to the science content more easily 33. Fictional literature should not be used during instruction because science is based on factual information 43. Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science	3. I have a limited background in using fictional literature to teach science 4. In order to use fictional literature to teach science, the teacher must know how to select books carefully 42. Fictional literature is underutilized in science instruction

Table 4-5 shows Tonya's choices of statements from the -3 and +3 columns as well. Erin and Sharon also placed statement 33 in the -3 column. Tonya's experience in elementary science "was not good," and she feels that "had [teachers] brought in fictional literature, it could have opened up more—a broader range." Using fictional literature gives science "more like a fun factor" and "makes it kid friendly." Tonya stated that she does not like science, though she feels like “had I been introduced to it in a different way, then I think I probably would because I could relate to it.” She plans to use fictional literature in her own science teaching.

Participant 6—Alana. Alana is a 21-year-old Hispanic/White female in her junior year of undergraduate work. She is enrolled in a teacher preparation program, and has completed some of the teacher preparation courses. After she graduates, she hopes to teach kindergarten, and would like to teach in a self-contained classroom. Alana “[does] not recall much science involvement” in elementary school other than a few projects like raising butterflies and dissecting owl pellets. Her more memorable experiences come from “things [she] did with her family outside of school.” Her middle school science experiences were characterized by “a lot of repetition.” She remembers:

> feeling annoyed when we’d have to go to the lab because it’d just be a bunch of measuring and weighing and volume and all the scientificky [sic] terms. They never taught us how to relate it to outside the classroom. It felt pointless.

It was not until college that Alana developed the mindset that science is everywhere, because “in elementary school, we just did those [science] topics.”

-4	-3	-2	-1	0	1	2	3	4
15	6	5	16	4	1	3	7	2
33	27	8	21	12	11	10	41	9
	43	14	22	20	13	18	42	
		34	28	24	17	23		
		38	29	25	19	40		
			32	26	30			
			37	31	39			
				35				
				36				

SubjNo: 6 ID: 21HWFFJN

Figure 4-6: Alana’s Q sort distribution results

Figure 4-6 shows Alana’s distribution of the 43 statements in the Q sort. The two statements with which she most agreed were 2) Fictional literature is beneficial in getting students excited about science, and 9) Fictional literature should be used during science instruction. Erin also placed statement 2 in the most agree column. Alana believes that "it's so easy to adapt a science lesson to fictional literature," and it is important to her that her future students are able to see science in everything.

The statements with which Alana most disagreed were 15) It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction, and 33) Fictional literature should not be used during instruction because science is based on factual information. Her rationale for strongly disagreeing with both of these statements is rooted in her view that science is all around us. Although science is based on factual information, she believes fictional literature should be used during instruction "just so students can have an open mind and not just see science as the laboratory setting, and can just apply science to everything." Sharon also placed statement 15 in the most disagree column, and Juniper placed statement 33 in that column.

Table 4-6: Alana's selections for -3 and +3

-3 (fairly strongly disagree)	+3 (fairly strongly agree)
6. When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning	7. Fictional literature can be used to make science more approachable to youth 41. Fictional literature should be used more as a teaching tool in science

27. Fictional literature will create too many misconceptions to make it a useful teaching tool for science 43. Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science	42. Fictional literature is underutilized in science instruction

Table 4-6 shows Alana's choices of statements from the -3 and +3 columns as well. There are some similarities between Alana's choices and other participants' choices. Tonya and Erin placed item 43 in the -3 column, and Juniper, Erin, and Sharon placed statement 27 in the -3 column. In the +3 column, Tonya also selected statement 42, Juniper selected 7, and Erin selected 41. Alana believes it is "easy to adapt a science lesson to fictional literature," and plans on combining the two once she begins teaching. She is excited about incorporating literature into her instruction because "there's so many interesting and exciting, engaging literature book that you could apply science to in easy ways."

Participant 7—Patricia. Patricia is a 21-year-old White female in her senior year of undergraduate work, and is also enrolled in a teacher preparation program. She has completed all of the teacher preparation courses other than student teaching. After she graduates, she hopes to teach second grade, and she would like to teach in a self-contained classroom. Patricia characterized her elementary science experience as "a very traditional science class. I didn't have labs, explorations, etc." She recalled elementary science being a subject that required a lot of reading. Once she reached second or third grade, she really started to dislike science because "it always had the most words in it," and she did not want to have to sit and read for long periods of time. However, she recalled her fourth grade science teacher with fondness because she was "super-fun, and super interested in making us have fun." Once a year, her elementary campus went on a Nature Trails field trip that included science experiments and explorations, and she found this to be a very rewarding experience. Patricia did not experience much interdisciplinary work as she progressed through school; she remembers having classrooms where "one teacher taught this, and the other teacher taught this—there was no—the intermingling of it." She stated that it wasn't until college that she started making connections because of the teaching skills of her professors. According to Patricia "Only just now did I realize the concept of a few different things that I know I've learned for such a long time, but I think I just recited them. It was in college when I understood." For example, her physics professor placed science concepts in a real-world context so that when she saw light, she would think about it being a mix of colors.

-4	-3	-2	-1	0	1	2	3	4
38	24	5	3	1	11	7	2	4
43	31	6	8	9	12	19	18	20
	34	14	17	10	13	21	30	
		15	28	23	16	22		
		33	37	27	25	26		
			39	35	29			
			40	36	32			
				41				
				42				

SubjNo: 7 ID: 21WFSA1

Figure 4-7: Patricia's Q sort distribution results

Figure 4-7 displays Patricia's distribution of the 43 statements in the Q sort. The two statements with which she most agreed were 4) In order to use fictional literature to teach science, the teacher must know how to select books carefully, and 20) Fictional literature stimulates students' imagination and curiosity about science. Like Sharon, who also selected statement 20 as a most agree item. Patricia reflected on the assignment that required students to select books they could use to teach the science TEKS when asked about the statements with which she most agreed. One of the books she chose was *Rosie Revere Engineer*, in which the main character was a young female. Patricia believes the character is someone to whom students could relate because of the way she solved problems, asked questions, and did investigations. However, she cautioned that teachers should know how to select books carefully, since "when [she] was picking the books, there would be—not fantasy—but just random things, where [she] was like, 'This might catch them off-guard a little bit.'" From her perspective, teachers need to be aware of elements of a story that might confuse their students, and be clear when talking about the science in the story with them.

The statements with which Patricia most disagreed were 38) Students will have a difficult time transferring science information from a fictional setting to a real-world one, and 43) Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science." Again, Patricia referenced careful book selection when discussing the items with which she disagreed, stating "that was what I was saying about choosing the books carefully as a teacher because—just making sure that it's not too crazy but that they're people that they can relate to." She believes that when books or characters are relatable, students likely will not have a difficult time pulling the science information from the story. Conversely, she believes that fantastic characters or story lines have the potential to create more confusion than science understanding. Erin also strongly disagreed with statement 38. Like Sharon, Patricia believes that using fictional literature "would make science more interesting and then get the kids who dislike language arts to take a second opinion about it using it in another class setting." Spenrico and Sharon also placed statement 43 in the -4 column.

Table 4-7: Patricia's selections for -3 and +3

-3 (fairly strongly disagree)	+3 (fairly strongly agree)
24. Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content 31. The accuracy of science content suffers in fictional literature 34. There is a time for fictional literature in elementary instruction, just not in science	2. Fictional literature is beneficial in getting students excited about science 18. Fictional literature has the potential to increase both students' science knowledge and reading achievement 30. Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts

Table 4-7 shows Patricia's choices of statements from the -3 and +3 columns. Sharon and Spenrico also placed item 34 in the -3 column, and Spenrico and Patricia both chose statement 18 for the +3 column. Patricia shared that the elementary science methods course provided her "my first taste of me teaching science and incorporating literature." She "really enjoyed it," and thinks it is "a really good tool to use." Some benefits she perceives are that it "is a fun way of attracting students [to science] with language arts and with stories." It aids in students' understanding and "helps curiosity."

Growing up, she thought science was intimidating and feels like if she had a teacher who had read stories during science, she might have thought "Hey, I could be a scientist," and been less intimidated and more interested in what she was learning. Patricia plans to use fictional literature to help her teach science.

Correlation Matrix

The correlation matrix displays "the extent and nature of the relationships that pertain between all the Q sorts in [the] study" (Watts & Stenner, 2012, p. 202). It is important to note that the correlation matrix reflects the relationship of each Q sort distribution with every other Q sort, and not the relationship of each statement with every other statement (Watts & Stenner, 2005). After I entered the distribution data for the seven focus group participants, the PQMethod software produced a .cor file with the correlation matrix. Table 4-8 displays the information in a readable format.

Table 4-8: Correlation matrix for focus group participants' sorts

		SORTS						
PARTICIPANT	**SORTS**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Erin	**1**	1.00	.55	.51	.58	.35	.47	.67
Sharon	**2**	.55	1.00	.55	.65	.33	.49	.53
Juniper	**3**	.51	.55	1.00	.39	.26	.53	.44
Spenrico	**4**	.58	.65	.39	1.00	.35	.48	.70
Tonya	**5**	.35	.33	.26	.35	1.00	.30	.34
Alana	**6**	.47	.49	.53	.48	.30	1.00	.45
Patricia	**7**	.67	.53	.44	.70	.34	.45	1.00

By following the first row, Erin's Q sort, one can see her sort has its strongest correlations with Patricia's sort (.67) and Spenrico's sort (.58), followed closely by Sharon's, Juniper's, and Alana's. The 1.00 value falls in the cell indicating the correlation between Q sort 1 and Q sort 1, so it should align 100% of the time, as each sort does with itself (all of the 1.00 values). Significant correlations are calculated using the equation 2.58 x (1/√No. items in Q set) (Watts & Stenner, 2012). For this data set, the equation is 2.58 x (1/√43), which yields a significant correlation of ±0.39. Any value at .39 or higher is significant, and all of the significant correlations are highlighted in the table. According to Fraenkel and Wallen (2009), when values are statistically significant, "the conclusion [is] that results are unlikely to have occurred due to sampling error or 'chance,' [indicating that] an observed correlation or difference probably exists in the population" (p. G-8). For the purposes of this study, I used the terms 'significant' and 'statistically significant' interchangeably.

Erin, Sharon, Juniper, Spenrico, Alana, and Patricia all have sorts that are significantly correlated to each other, and these are the group of Q sorts that exemplify Factor 1 (see next section). Although these six participants' Q sorts are considered statistically significant, the highest value among them is .70. Scores closer to 1.00 indicate Q sorts that have a great deal in common with each other in terms of placement of the statements on the distribution sheets. Because the highest correlation among these six participants is only .70, it is indicative that there is some difference of opinion between the six participants in terms of their selections during the Q sort process, although a fair amount of statements was placed in the same column on the distribution sheets. Q sort 5, which is Tonya's distribution, does not significantly correlate to the other Q sorts in the study; though there is some overlap, it is not considered statistically significant.

Other than the 1.00 values, the highest correlation in the matrix is between Spenrico and Patricia (.70). This indicates that their Q sorts were more closely aligned than with other participants, with 70% of their distributions being the same. Although values below .39 are not considered significant, they yield important information as well. Tonya's sort, whose highest correlation is .35 with Spenrico, did not closely align with the other participants. From this, one might assume she has an entirely different perspective than the other participants. However, in reading the explanation of her choices in her section, one can see her perspective on incorporating fictional literature in science is positive, much like the other participants. Further exploration of the data is required, and the factor matrix and factor arrays help break it down and provide more clarity.

Factor Matrix

When prompted by the PQMethod software, I instructed the program to extract two factors. Watts and Stenner (2012) recommended selecting one factor for every six participants in a study. Because this set of participants has seven people, I selected two factors.

Table 4-9: Factor matrix with an X indicating a defining sort

	FACTOR LOADINGS	
Participant/Sort	**Factor 1**	**Factor 2**
Erin 1	0.7186**X**	0.3679
Sharon 2	0.7731**X**	0.2485
Juniper 3	0.7980**X**	-0.0132
Spenrico 4	0.6859**X**	0.4458
Tonya 5	0.1223	0.9159**X**
Alana 6	0.7386**X**	0.1157
Patricia 7	0.6964**X**	0.4236
% EXPLAINED VARIANCE	**47%**	**20%**

The process of factor extraction involves "the identification of distinct regularities or patterns of similarity in the Q-sort configurations entered into PQMethod" (Watts &

Stenner, 2012, p. 100). In other words, each factor represents a new Q sort distribution that attempts to synthesize the shared viewpoints of the participants. A breakdown of each factor's distribution can be seen in the factor arrays section, which follows this one. The PQMethod program takes all of the sorts that have large portions of shared data and arranges them into the various factors. A factor exists "when a group of variables [such as the different placement of the statements in the participants' card sorts] has for some reason, a great deal in common" (Du Plessis, 2005, p. 160). This process of identifying factors takes a very large set of data and reduces it down to a smaller set, i.e. the factors.

In running the factor extraction, the PQMethod program searched for a "first, shared pattern or sorting configuration in the data" (Watts & Stenner, 2012, p. 100), which became Factor 1. Factor 1 is a "best-estimate" (p. 82) of the largest portion of the participants' shared viewpoints. According to Watts and Stenner (2012), "It is usual in factor analysis that the first factor extracted will account for the largest amount of study variance with successive factors steadily decreasing in size," (p. 100) as is shown in Table 4-9 by the explained variance values of 47% and 20% for factors 1 and 2 respectively. Factor 1 accounts for 47%, or almost half, of everything that all seven of the Q sorts have in common. Factor 2 accounts for 20%, or 1/5, of everything they have in common. Together, these two factors account for 67% of the variance. According to Brown (1980), "an important characteristic of the final set of factors is that they should account for as much of the variability in the original correlation matrix as possible" (p. 209). Watts and Stenner (2012) cite 35-40% combined factor variance as being sound, so the combined value of 67% for factors 1 and 2 indicate a successful factor extraction.

During the factor extraction process, a measure is provided that tells the extent to which each Q sort is typical of each factor. This measure is expressed in the form of a correlation coefficient, meaning a statistical relationship between the individual sort and the factor, and is known as a factor loading. According to Brown (1993), "factor loadings in excess of ± 0.50 can be considered significant" (p. 112). The PQMethod software flagged the individual sorts that significantly loaded on each factor. Erin's, Sharon's, Juniper's, Spenrico's, Alana's, and Patricia's sorts are marked with an **X** in Table 4-9 for factor 1, indicating they correlate significantly with that factor. Juniper's sort correlated most significantly (.798) out of all of the participants; she had almost 80% of her sort in common with factor 1. Sort 5, Tonya's, correlates significantly with factor 2. In fact, over 90% of her Q sort selections overlap with the arrangement of statements in factor 2, seen below.

Factor Arrays

Watts and Stenner (2012) describe the factor arrays as "probably the most important table of all!" (p. 211). Table 4-10 shows all 43 statements and their rankings in the distribution for the two factors. This is a formatted version of the information produced by the PQMethod software in a file titled 'Factor Q-sort values for each statement,' which "form[s] the basis of [the] factor interpretations" (p. 140). In this section, the same information will be displayed in three different ways to provide additional clarity about the factors.

Table 4-10: Factor arrays

		Factor Arrays	
Q Statements		**1**	**2**
1	Fictional literature and science both encourage students to think critically	0	0
2	Fictional literature is beneficial in getting students excited about science	3	-2

3	I have a limited background in using fictional literature to teach science	-1	3
4	In order to use fictional literature to teach science, the teacher must know how to select books carefully	1	3
5	Teachers used fictional literature in my science classes when I was in elementary school	-1	0
6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning	-2	0
7	Fictional literature can be used to make science more approachable to youth	4	-1
8	Fictional literature may lead to misconceptions about science if it adds too much fantasy	-1	0
9	Fictional literature should be used during science instruction	1	-1
10	Using fictional literature will increase students' science comprehension skills	1	0
11	I think that using fictional literature to teach science will get the children more engaged and interested in science	2	-2
12	Using fictional literature during science instruction will help elaborate on the concepts being taught	0	-1
13	Fictional literature helps make a difficult science concept easier to understand	1	2
14	Fictional literature uses science vocabulary that is more suited for children than non-fiction	0	0
15	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction	-2	0
16	Fictional literature should be used to teach science only if it includes actual facts with the story	-1	-2
17	Fictional literature helps teach the science TEKS	0	-1
18	Fictional literature has the potential to increase both students' science knowledge and reading achievement	2	2
19	I would like to know more about how to incorporate fictional literature into science teaching/learning	2	2
20	Fictional literature stimulates students' imagination and curiosity about science	4	1
21	Fictional literature should be used to teach science because all subject areas are linked	-1	-1
22	Fictional literature will help stimulate students' imagination about science	1	4
23	Using fictional literature helps children get a better understanding of the science content	3	2
24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content	-2	-4
25	Using fictional literature helps students access their prior knowledge	-1	4
26	Using fictional literature will help students connect to the science content more easily	3	-3
27	Fictional literature will create too many misconceptions to make it a useful teaching tool for science	-3	-2
28	Non-fictional literature should be used more than fictional literature in science instruction	-2	-4
29	Using fictional literature will make science more relatable to students	2	-1
30	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts	1	1
31	The accuracy of science content suffers in fictional literature	-2	-1
32	Reading books is an important part of science instruction	0	0
33	Fictional literature should not be used during instruction because science is based on factual information	-4	-3
34	There is a time for fictional literature in elementary instruction, just not in science	-3	-2
35	Using fictional literature encourages students to make predictions, which is an important skill in science	0	1
36	Using fictional literature broadens the range of science content to which students are exposed	0	1
37	There is a lack of understanding about how fictional literature can be used to support science instruction	0	1
38	Students will have a difficult time transferring science information from a fictional setting to a real-world one	-3	0
39	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts	0	1

40	Fictional literature will help students acquire scientific habits of mind	-1	2
41	Fictional literature should be used more as a teaching tool in science	2	1
42	Fictional literature is underutilized in science instruction	1	3
43	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science	-4	-3

Factor arrays are useful because they are similar to the format in which that data was originally collected (Brown, 1980), i.e. the distribution from -4 (strongly disagree) to 4 (strongly agree), making it "easier for a study's audience or readership to understand" (Watts & Stenner, 2012, p. 140). For example, statement 1 has a value of 0 in both factor 1 and factor 2, meaning it is a neutral statement in each factor. Statement 7 has a 4 (strongly agree) value in factor 1, while it has a -1 value (slightly disagree) value in factor 2. Factor arrays always conform to the same distribution as in the sheet given to participants during the Q sort process (Watts & Stenner, 2012), so the statements in these arrays will range from -4 to +4 values, as seen in figures 4-8 and 4-9.

-4				0				+4
33	27	6	3	1	4	11	2	7
43	34	15	5	12	9	18	23	20
	38	24	8	14	10	19	26	
		28	16	17	13	29		
		31	21	32	22	41		
			25	35	30			
			40	36	42			
				37				
				39				

Figure 4-8: Distribution of statements for factor 1

-4				0				+4
24	26	2	7	1	20	13	3	22
28	33	11	9	5	30	18	4	25
	43	16	12	6	35	19	42	
		27	17	8	36	23		
		34	21	10	37	40		
			29	14	39			
			31	15	41			
				32				
				38				

Figure 4-9: Distribution of statements for factor 2

Although arrays attempt to display a holistic picture of each factor, there are some limitations. There is very little chance that any one participant's sort will load 100% on any factor (Watts & Stenner, 2012). For this data set, Juniper's loading on factor 1 was 0.7980 (as seen in Table 4-9 in the preceding section), or 79.8%, which was the highest degree of any one participant's correlation to factor 1. Even though 100% correlation is highly unlikely, "the main goal of a factor array is to provide a best possible estimate of the relevant factor and, in so doing, to give a sense of what its 100% or perfectly loading Q sort might actually look like" (Watts & Stenner, 2012, p. 141). It essentially provides an approximation of what the largest portion of shared viewpoints would look like if they were combined into one distribution. Figure 4-8 is that "best estimate" of the largest portion of shared information. Figure 4-9 shows the distribution for factor two. As seen in Table 4-9, Tonya loaded significantly on this factor with a value of 0.9159, or almost 92%. Upon examining Tonya's distribution (Figure 4-5), one can see that factor two's sort and her sort very closely align, with only slight differences.

Interpreting the factor arrays. According to Watts and Stenner (2012), "After the statistical digression needed to identify the factors, the interpretation should bring back to life and communicate something of the feeling that informed the original Q-sorting process" (p. 159). To perform the interpretation, first I examined the statements at either end of each factor's spectrum (±3, ±4), which are indicative of the strongest feelings, followed by the statements towards the middle of the spectrum (Du Plessis, 2005; Watts & Stenner, 2012). When examining the factors, it is important to note that, "Each individual item in a particular configuration has its place and ranking for a reason" (Watts & Stenner, 2012, p. 155). The researcher constantly should question the implications of each statement's placement, considering why it is ranked where it is, and attempting to generate a hunch or hypothesis (Watts & Stenner, 2012). Watts and Stenner (2012) noted, "This is the logic of abduction at work" (p. 155). The hypothesis should be proposed on the basis of evidence in the form of the rankings of other items, participant commentary, and/or any relevant demographic information (Watts & Stenner, 2012). Using this procedure, "a clear sense of the factor's viewpoint should begin to emerge" (p. 156). Each write-up of the factors should include a summary of relevant statistical information and a name for the factor. The name, as constructed by the researcher, should "capture the essence or main thrust of the viewpoint in as few words as possible" (p. 160). There are two styles of interpretation: the narrative style in which a seamless account of the factor's viewpoint is presented, or the commentary style which "involves the wording of each relevant item being cited in full and the weaving of an interpretive commentary around those citations" (p. 162). In either case, the interpretations are written as a set of declarative statements about the viewpoint expressed by the factor, as demonstrated in Watts and Stenner's examples (2012). I used the narrative style to convey more of the feeling represented in each factor. When focus group participants loaded on a particular factor, I used their commentary to support the interpretation of the factors as well.

Interpretation of factor 1: Fiction builds bridges. Factor 1 explained 47% of the study's variance, and Erin, Sharon, Juniper, Spenrico, Alana, and Patricia all loaded on this factor. As seen in Figure 4-10, the two statements that were ascribed the most agreement (+4) in factor 1 were 7 (fictional literature can be used to make science more approachable to youth) and 20 (fictional literature stimulates students' imagination and curiosity about science). Although no one participant's sort correlated 100% to factor 1, Spenrico placed statement seven in the +4 column, and Sharon and Patricia placed statement 20 in that column as well. The two statements with the highest degree of disagreement (-4) were 33 (fictional literature should not be used during science instruction because it is based on factual information) and 43 (using fictional literature during science instruction will cause students who dislike language arts to become less interested in science). Juniper and Alana placed statement 33 in the -4, or most disagree column, and Sharon, Spenrico, and Patricia placed statement 43 in the -4 column.

Items Ranked at +4

7 Fictional literature can be used to make science more approachable to youth
20 Fictional literature stimulates students' imagination and curiosity about science

Items Ranked at +3

2 Fictional literature is beneficial in getting students excited about science
23 Using fictional literature helps children get a better understanding of the science content
26 Using fictional literature will help students connect to the science content more easily

Figure 4-10: Factor 1 statements organized by placement on distribution sheet

Items Ranked at +2

11	I think that using fictional literature to teach science will get the children more engaged and interested in science
18	Fictional literature has the potential to increase both students' science knowledge and reading achievement
19	I would like to know more about how to incorporate fictional literature into science teaching/learning
29	Using fictional literature will make science more relatable to students
41	Fictional literature should be used more as a teaching tool in science

Items Ranked at +1

4	In order to use fictional literature to teach science, the teacher must know how to select books carefully
9	Fictional literature should be used during science instruction
10	Using fictional literature will increase students' science comprehension skills
13	Fictional literature helps make a difficult science concept easier to understand
22	Fictional literature will help stimulate students' imagination about science
30	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts
42	Fictional literature is underutilized in science instruction

Items Ranked at 0

1	Fictional literature and science both encourage students to think critically
12	Using fictional literature during science instruction will help elaborate on the concepts being taught
14	Fictional literature uses science vocabulary that is more suited for children than non-fiction
17	Fictional literature helps teach the science TEKS
32	Reading books is an important part of science instruction
35	Using fictional literature encourages students to make predictions, which is an important skill in science
36	Using fictional literature broadens the range of science content to which students are exposed
37	There is a lack of understanding about how fictional literature can be used to support science instruction
39	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts

Items Ranked at -1

3	I have a limited background in using fictional literature to teach science

Figure 4-10 cont.

5	Teachers used fictional literature in my science classes when I was in elementary school
8	Fictional literature may lead to misconceptions about science if it adds too much fantasy
16	Fictional literature should be used to teach science only if it includes actual facts with the story
21	Fictional literature should be used to teach science because all subject areas are linked
25	Using fictional literature helps students access their prior knowledge
40	Fictional literature will help students acquire scientific habits of mind
Items Ranked at -2	
6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning
15	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content
28	Non-fictional literature should be used more than fictional literature in science instruction
31	The accuracy of science content suffers in fictional literature
Items Ranked at -3	
27	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
34	There is a time for fictional literature in elementary instruction, just not in science
38	Students will have a difficult time transferring science information from a fictional setting to a real-world one
Items Ranked at -4	
33	Fictional literature should not be used during instruction because science is based on factual information
43	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science

Figure 4-10 cont.

This factor is titled *Fiction builds bridges* because of the strong recognition of the potential benefits of using fictional literature during elementary science instruction. It is clear that the perspective represented by this factor acknowledges the need for students to connect to the content (statement 26: +3 ranking) in order to make it more approachable (7: +4). Patricia reinforced the notion that stories make science more approachable when she stated, “This is a fun way of attracting students [to science] with language arts and with stories." Because using a fictional story will help build excitement about science (2: +3; 11: +2), it is easier for the students to connect to the material which, in turn, helps students gain a better understanding of the science information (23: +3). According to Alana, "Reading a fictional literature book can open the students' eyes to realizing that science is in everyday life, and can make them excited." Erin's personal background in elementary science impacted her view that stories help build understanding because "it was easier to picture [the science content] when [she] had a visual like that and it just got [her] way more excited about science."

This factor dismissed many of the potential drawbacks to using fictional literature in the classroom (27: -3; 38: -3; 6: -2; 24: -2), resulting in a strong disagreement that fictional literature should not be used during instruction because science is based on facts rather than stories (33: -4; 34: -3). Although Spenrico acknowledged that students could develop misconceptions when teachers read fictional stories during science time, the shared perspective of this factor is that the potential for those misconceptions does not negate its usefulness as a teaching tool in science (27: -3). Spenrico further explained that, "all a teacher would have to do is explain it well and then avoid basically any of the misconceptions that the fictional literature might impart upon the students." There were much stronger feelings about the benefits (building excitement, making science approachable) and drawbacks to using fictional literature than recognition of the shared skills and practices between the science and language arts disciplines (1: 0; 35: 0; 10: +1). Similarly, this factor has a limited perspective on factors that make fictional literature a useful tool for science instruction. Accessing prior knowledge (25: -1), acquiring scientific habits of mind (40: -1), providing a foundation on which to build and develop students' understanding of science (39: 0), and helping link personal experience with facts and new concepts (30: +1) largely fell into the neutral range.

***Interpretation of factor 2*: *Learning from lack of use*.** Factor 2 explained 20% of the study's variance, and Tonya loaded on this factor. As seen in Figure 4-11, the two statements that were ascribed the most agreement (+4) in factor 2 were 22 (fictional literature will help stimulate students' imagination about science) and 25 (using fictional literature helps students access prior knowledge). Tonya placed both of these statements in the most agree column; none of the other participants did, though Erin placed statement 22 in the +3 column. The two statements with the most disagreement (-4) were 24 (using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content) and 28 (non-fictional literature should be used more than fictional literature in science instruction). Tonya placed both statements in the -4, or most disagree column, and Erin placed statement 24 there as well. It is not surprising that Tonya's selections align so closely with the array for factor 2, since her sort loaded on factor 2 with a correlation of 91.59%, as seen in Table 4-9.

Items Ranked at +4	
22	Fictional literature will help stimulate students' imagination about science
25	Using fictional literature helps students access their prior knowledge
Items Ranked at +3	
3	I have a limited background in using fictional literature to teach science
4	In order to use fictional literature to teach science, the teacher must know how to select books carefully
42	Fictional literature is underutilized in science instruction
Items Ranked at +2	
13	Fictional literature helps make a difficult science concept easier to understand

Figure 4-11: Factor 2 statements organized by placement on distribution sheet

18	Fictional literature has the potential to increase both students' science knowledge and reading achievement
19	I would like to know more about how to incorporate fictional literature into science teaching/learning
23	Using fictional literature helps children get a better understanding of the science content
40	Fictional literature will help students acquire scientific habits of mind
Items Ranked at +1	
20	Fictional literature stimulates students' imagination and curiosity about science
30	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts
35	Using fictional literature encourages students to make predictions, which is an important skill in science
36	Using fictional literature broadens the range of science content to which students are exposed
37	There is a lack of understanding about how fictional literature can be used to support science instruction
39	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts
41	Fictional literature should be used more as a teaching tool in science
Items Ranked at 0	
1	Fictional literature and science both encourage students to think critically
5	Teachers used fictional literature in my science classes when I was in elementary school
6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning
8	Fictional literature may lead to misconceptions about science if it adds too much fantasy
10	Using fictional literature will increase students' science comprehension skills
14	Fictional literature uses science vocabulary that is more suited for children than non-fiction
15	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
32	Reading books is an important part of science instruction
38	Students will have a difficult time transferring science information from a fictional setting to a real-world one
Items Ranked at -1	
7	Fictional literature can be used to make science more approachable to youth
9	Fictional literature should be used during science instruction
12	Using fictional literature during science instruction will help elaborate on the concepts being taught
17	Fictional literature helps teach the science TEKS

Figure 4-11 cont.

21	Fictional literature should be used to teach science because all subject areas are linked
29	Using fictional literature will make science more relatable to students
31	The accuracy of science content suffers in fictional literature
Items Ranked at -2	
2	Fictional literature is beneficial in getting students excited about science
11	I think that using fictional literature to teach science will get the children more engaged and interested in science
16	Fictional literature should be used to teach science only if it includes actual facts with the story
27	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
34	There is a time for fictional literature in elementary instruction, just not in science
Items Ranked at -3	
26	Using fictional literature will help students connect to the science content more easily
33	Fictional literature should not be used during instruction because science is based on factual information
43	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science
Items Ranked at -4	
24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content
28	Non-fictional literature should be used more than fictional literature in science instruction

Figure 4-11 cont.

Factor 2 is titled *Learning from lack of use*. This title reflects that individual backgrounds and experiences with the use of fictional literature during science may play a role in these perspectives (3: +3). According to Tonya, "had [her teachers] brought in fictional literature it could open up a more—a broader range" of understanding. She primarily remembers using mostly "heavy textbooks" when any type of reading was done in elementary science. The lack of use of fictional literature in her own experience helped Tonya develop ideas about what not to do once she becomes a practicing teacher.

The viewpoint represented in this factor is that fictional literature should be used in science instruction equal to or more than non-fictional literature (28: -4). Reasons for this include the fact that stories help stimulate students' imagination about science (22: +4) and tap into their prior knowledge (25: +4). Tonya believed that "fictional literature will help stimulate students' imagination about science because like when they're little, they are all like imagination and stuff like that, and that's when you wanna spark them—like start it from kind to build up." The fantastical nature of some stories will not limit students' abilities to pick up on the science content (24: -4), and it is not necessary to include actual facts in the stories to make them useful science teaching tools (16: -2). Erin found that science "was easier to picture when [she] had a visual" like ones found in stories. Although natural to assume that stimulating imagination might translate to engagement with and excitement about science, this is not the viewpoint represented by this factor (2: -2; 11: -2). Even though it might not equate to excitement, fictional literature helps students get a better understanding of science content (23: +2) and may increase both students' science knowledge and reading achievement (18: +2).

Despite all its advantages, fictional literature is underutilized in science instruction (42: +3), possibly because teachers must know how to select fictional books carefully in order to use them effectively (4: +3). Because this skill is necessary, more instruction in how to incorporate fictional literature into science teaching and learning would be beneficial (19: +2). Tonya has "always wanted to learn how to teach [science] better to kids and get them excited about it so that they can grow up to do science jobs like engineers or go into caves."

Conclusion

In this chapter results were shared that first focused on the individual viewpoints of seven participants, displayed in seven Q sorts along with a description of each participant's background and rationale for their Q sort selections, followed by the correlation matrix and factor arrays. The goal of the data analysis via PQMethod software was to reduce the complexity of the data on the basis of common ground that was present in the data (Watts & Stenner, 2012). At the culmination of the factor extraction process, seven Q sorts were effectively reduced to two, represented by their own unique Q factor arrays and distributions. The interpretation that follows each one tells the story of the factor. This process is continued in chapter five with the data from all 38 participants.

V. FULL GROUP RESULTS AND INTERPRETATION

The purpose of this chapter is to reveal a broader picture of the data collected about teacher candidates' perceptions regarding the integration of fictional literature into elementary science instruction via a Q methodology card sort. This chapter addresses the primary research question: What are the thoughts, feelings, and beliefs held by teacher candidates regarding the integration of fictional literature into elementary science instruction? The participants' arrangements of the statements in their distributions also provide insight into the sub-questions about benefits and disadvantages of incorporating fictional literature into elementary science instruction. The same type of information as in chapter four is presented, but for all 38 participants in the study. This chapter begins with an overview of the participants rather than the full description for each one as in chapter four. I collected some basic demographic and background information from all of the participants, but everything was anonymous so it was not possible to match the demographic information to each individual sort. The chapter concludes with the presentation and interpretation of the correlation matrix, factor matrix, and factor arrays.

Participants

Participants included 38 volunteers from two sections of the elementary science methods course I teach. In the first section, there were 25 students, and 20 volunteered. In the second section, there were 22 students, and 18 volunteered. The information for both sections is combined because, for the purposes of this study, there is no reason to keep them separated. There were 35 females and 3 males in the full participant group, which reflects the overall gender distribution in both sections. Ages ranged from 20 to 47, with the average age being 24. The majority of the participants were in their early

20s, with 24 participants self-identifying as White, 11 as Hispanic, two as mixed races/ethnicities, and one as Asian. Thirty-three of the participants were in their senior year of undergraduate work, while five were in their junior year. Fifteen reported that they had completed all of their courses in the teacher preparation program other than student teaching. Eighteen others had completed most of the teacher preparation courses, and five had completed less than half.

When asked in writing on the demographics information sheet to describe their experiences in elementary science, the participants' responses varied in length from a single phrase to a full paragraph. Two significant themes stood out in their answers. The first theme, labeled teacher led instruction was not enjoyable, was that 17 participants reported that their elementary science instruction was very teacher directed, with the frequent use of textbooks and/or worksheets. These participants tended not to have positive feelings about their elementary science experiences, exemplified by the participant who stated it was all "workbooks and bad experiences." Although not all the participants felt it was that negative, other comments such as "my instruction was always busy work," led this participant to state "she has no enjoyment for science." Another participant stated, "it was mainly whole class instruction… so I did not enjoy most of it." A third participant remembered, "we did a lot of bookwork and defining terms… I did not enjoy it very much." One participant recalled that science time frequently would be used to finish any math or language arts that needed to be completed, making science "not a top priority" that was filled with "a lot of worksheets—nothing really hands on." Interestingly, several of the participants characterized this teacher led, textbook and worksheet driven instruction as "traditional." One participant stated:

> My elementary science experiences were mostly traditional and instructional. We did not spend a lot of time doing hands on experiments, maybe one or two a semester. We did a lot of textbook/worksheets. These experiences have molded me to not be as fond of science overall.

The second theme, labeled forgettable experience, was that it was challenging for participants to remember much about the nature of their science instruction during elementary school, as reported by 11 participants. Participants commented that, "I don't remember elementary science," "I do not remember much about science in elementary school," and "I remember having science rotation everyday [sic], but I don't remember what we did." For some, a few science activities stand out in their memories, although the rest of the instruction was difficult to remember. As one participant wrote, "in 3rd we had a garden and then in 5th grade we had a dead bug collection and those were really cool and that's all I remember." A few participants addressed the amount of time spent on science instruction during their elementary experiences, and it ranged from once or twice a week to every day for up to an hour. Five participants reported enjoying science in elementary school. For most of these participants, the reasons were that they "did hands-on activities" and "had some labs."

Correlation Matrix

The individual Q sort distributions for all participants (n = 38) are displayed in Appendix H. The correlation matrix information for all of the participants produced by the PQMethod software is displayed in the formatted Table 5-1.

Table 5-1: Correlation matrix for full group Q sorts

Correlation Matrix Between Sorts

SORTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	1.00	0.39	0.65	0.58	0.35	0.46	0.66	0.26	0.53	0.51	0.60	0.55	0.44	0.77	0.48	0.33	0.62	0.41	0.48	0.70	0.47	0.67	0.41	0.62	0.54	0.41	0.50	0.53	0.50	0.63	0.70	0.47	0.52	0.44	0.50	0.55	0.17	0.49
2	0.39	1.00	0.55	0.51	0.26	0.26	0.45	0.61	0.56	0.47	0.58	0.57	0.48	0.41	0.61	0.17	0.53	0.49	0.53	0.44	0.12	0.62	0.08	0.53	0.72	0.18	0.29	0.50	0.71	0.56	0.53	0.29	0.65	0.45	0.68	0.70	0.42	0.53
3	0.65	0.55	1.00	0.55	0.33	0.30	0.49	0.42	0.56	0.51	0.64	0.58	0.48	0.51	0.49	0.23	0.60	0.40	0.49	0.53	0.05	0.57	0.18	0.49	0.60	0.26	0.24	0.58	0.57	0.48	0.58	0.43	0.45	0.38	0.53	0.59	0.15	0.55
4	0.58	0.51	0.55	1.00	0.35	0.46	0.50	0.46	0.48	0.54	0.58	0.56	0.56	0.59	0.52	0.23	0.51	0.58	0.47	0.67	0.02	0.47	0.03	0.55	0.57	0.28	0.35	0.51	0.49	0.43	0.51	0.27	0.47	0.41	0.59	0.55	0.16	0.40
5	0.35	0.26	0.33	0.35	1.00	-0.02	0.47	0.21	0.34	0.34	0.26	0.41	0.16	0.41	0.24	-0.06	0.22	0.27	0.30	0.34	0.44	0.22	0.26	0.21	0.27	0.40	0.37	0.17	0.30	0.20	0.27	0.49	0.28	0.38	0.32	0.41	0.34	0.48
6	0.46	0.26	0.30	0.46	-0.02	1.00	0.19	0.31	0.26	0.28	0.34	0.13	0.16	0.40	0.33	0.51	0.34	0.38	0.16	0.52	0.07	0.34	0.20	0.51	0.27	0.37	0.17	0.34	0.27	0.56	0.44	0.01	0.49	0.30	0.31	0.56	-0.08	0.34
7	0.66	0.45	0.49	0.50	0.47	0.19	1.00	0.14	0.48	0.46	0.51	0.52	0.31	0.62	0.36	0.22	0.52	0.29	0.44	0.44	0.51	0.61	0.34	0.54	0.46	0.37	0.55	0.34	0.35	0.49	0.52	0.44	0.33	0.47	0.38	0.47	0.16	0.40
8	0.26	0.61	0.42	0.46	0.21	0.31	0.14	1.00	0.47	0.41	0.51	0.56	0.47	0.44	0.62	0.18	0.48	0.46	0.33	0.49	0.06	0.48	0.05	0.41	0.48	0.23	0.06	0.38	0.51	0.42	0.51	0.26	0.54	0.59	0.54	0.58	0.55	0.48
9	0.53	0.56	0.56	0.48	0.34	0.26	0.48	0.47	1.00	0.37	0.52	0.64	0.41	0.55	0.65	0.10	0.68	0.55	0.50	0.55	0.27	0.65	0.45	0.63	0.64	0.21	0.26	0.59	0.67	0.44	0.64	0.45	0.39	0.55	0.53	0.53	0.32	0.51
10	0.51	0.47	0.51	0.54	0.34	0.28	0.46	0.41	0.37	1.00	0.47	0.51	0.54	0.49	0.48	0.17	0.52	0.37	0.44	0.52	0.38	0.55	0.14	0.45	0.58	0.48	0.45	0.41	0.47	0.48	0.52	0.42	0.49	0.33	0.47	0.55	0.29	0.59
11	0.60	0.58	0.64	0.58	0.26	0.34	0.51	0.51	0.52	0.47	1.00	0.54	0.51	0.58	0.62	0.06	0.53	0.53	0.63	0.55	0.23	0.66	0.20	0.47	0.66	0.34	0.26	0.66	0.54	0.53	0.53	0.31	0.66	0.53	0.56	0.66	0.27	0.30
12	0.55	0.57	0.58	0.56	0.41	0.13	0.52	0.56	0.64	0.51	0.54	1.00	0.54	0.55	0.61	0.09	0.60	0.44	0.63	0.59	0.28	0.60	0.30	0.45	0.64	0.30	0.42	0.39	0.49	0.41	0.72	0.49	0.33	0.43	0.43	0.51	0.45	0.55
13	0.44	0.48	0.48	0.56	0.16	0.16	0.31	0.47	0.41	0.54	0.51	0.54	1.00	0.41	0.48	-0.01	0.44	0.41	0.44	0.49	0.09	0.38	0.70	0.46	0.53	0.08	0.00	0.45	0.53	0.34	0.48	0.38	0.39	0.48	0.60	0.32	0.28	0.27
14	0.77	0.41	0.51	0.59	0.41	0.40	0.62	0.44	0.55	0.49	0.58	0.55	0.41	1.00	0.54	0.24	0.54	0.43	0.34	0.63	0.46	0.52	0.23	0.59	0.45	0.48	0.41	0.37	0.53	0.59	0.57	0.38	0.49	0.58	0.45	0.59	0.33	0.44
15	0.48	0.61	0.49	0.52	0.24	0.33	0.36	0.62	0.65	0.48	0.62	0.61	0.48	0.54	1.00	0.14	0.64	0.66	0.69	0.67	0.21	0.60	0.18	0.53	0.69	0.36	0.27	0.66	0.56	0.50	0.66	0.45	0.63	0.65	0.71	0.72	0.18	0.53
16	0.33	0.17	0.23	0.23	-0.06	0.51	0.22	0.18	0.10	0.17	0.06	0.09	-0.01	0.24	0.14	1.00	0.31	0.15	0.01	0.45	0.22	0.24	0.04	0.38	0.20	0.27	0.41	0.12	0.23	0.47	0.35	0.01	0.30	0.13	0.10	0.28	-0.01	0.37
17	0.62	0.53	0.60	0.51	0.22	0.34	0.52	0.48	0.68	0.52	0.53	0.60	0.44	0.54	0.64	0.31	1.00	0.58	0.59	0.62	0.22	0.67	0.15	0.52	0.76	0.24	0.32	0.61	0.55	0.46	0.59	0.43	0.50	0.50	0.57	0.56	0.32	0.51
18	0.41	0.49	0.40	0.58	0.27	0.38	0.29	0.46	0.55	0.37	0.53	0.44	0.41	0.43	0.66	0.15	0.58	1.00	0.49	0.60	0.06	0.41	0.13	0.49	0.48	0.27	0.12	0.52	0.55	0.48	0.44	0.21	0.53	0.62	0.63	0.51	0.17	0.28
19	0.48	0.53	0.49	0.47	0.30	0.16	0.44	0.33	0.50	0.44	0.63	0.63	0.44	0.34	0.69	0.01	0.59	0.49	1.00	0.45	0.29	0.62	0.19	0.33	0.70	0.34	0.32	0.51	0.42	0.45	0.58	0.34	0.47	0.43	0.54	0.57	0.26	0.38
20	0.70	0.44	0.53	0.67	0.34	0.52	0.44	0.49	0.55	0.52	0.55	0.59	0.49	0.63	0.67	0.45	0.62	0.60	0.45	1.00	0.28	0.58	0.27	0.62	0.53	0.45	0.42	0.52	0.55	0.57	0.64	0.34	0.60	0.49	0.59	0.69	0.28	0.59
21	0.47	0.12	0.05	0.02	0.44	0.07	0.51	0.06	0.27	0.38	0.23	0.28	0.09	0.46	0.21	0.22	0.22	0.06	0.29	0.28	1.00	0.45	0.44	0.33	0.25	0.38	0.49	0.08	0.19	0.44	0.40	0.32	0.35	0.37	0.10	0.29	0.29	0.27
22	0.67	0.62	0.57	0.47	0.22	0.34	0.61	0.48	0.65	0.55	0.66	0.60	0.38	0.52	0.60	0.24	0.67	0.41	0.62	0.58	0.45	1.00	0.41	0.58	0.69	0.44	0.40	0.48	0.53	0.66	0.67	0.39	0.54	0.50	0.46	0.62	0.36	0.55
23	0.41	0.08	0.18	0.03	0.26	0.20	0.34	0.05	0.45	0.14	0.20	0.30	0.07	0.23	0.18	0.04	0.15	0.13	0.19	0.27	0.44	0.41	1.00	0.28	0.16	0.17	0.33	0.10	0.12	0.28	0.35	0.31	0.18	0.27	0.16	0.30	0.22	0.28
24	0.62	0.53	0.49	0.55	0.21	0.51	0.54	0.41	0.63	0.45	0.47	0.45	0.46	0.59	0.53	0.38	0.52	0.49	0.33	0.62	0.33	0.58	0.28	1.00	0.45	0.33	0.38	0.58	0.55	0.60	0.68	0.35	0.49	0.59	0.64	0.57	0.16	0.45
25	0.54	0.72	0.60	0.57	0.27	0.27	0.46	0.48	0.64	0.58	0.66	0.64	0.53	0.45	0.69	0.20	0.76	0.48	0.70	0.53	0.25	0.69	0.16	0.45	1.00	0.33	0.38	0.66	0.53	0.44	0.52	0.46	0.55	0.47	0.56	0.61	0.38	0.58
26	0.41	0.18	0.26	0.28	0.40	0.37	0.37	0.23	0.21	0.48	0.34	0.30	0.08	0.48	0.36	0.27	0.24	0.27	0.34	0.45	0.38	0.33	0.17	0.33	0.33	1.00	0.51	0.32	0.25	0.48	0.32	0.39	0.30	0.33	0.27	0.58	0.08	0.45
27	0.50	0.29	0.24	0.35	0.37	0.17	0.55	0.06	0.26	0.45	0.26	0.42	0.00	0.41	0.27	0.41	0.32	0.12	0.32	0.42	0.49	0.40	0.33	0.38	0.38	0.51	1.00	0.27	0.10	0.38	0.42	0.30	0.34	0.06	0.20	0.47	0.23	0.52
28	0.53	0.50	0.58	0.51	0.17	0.34	0.34	0.38	0.59	0.41	0.66	0.39	0.45	0.37	0.66	0.12	0.61	0.52	0.51	0.52	0.08	0.48	0.10	0.58	0.66	0.32	0.27	1.00	0.53	0.45	0.46	0.46	0.62	0.47	0.69	0.60	0.02	0.41
29	0.50	0.71	0.57	0.49	0.30	0.27	0.35	0.51	0.67	0.54	0.54	0.49	0.53	0.53	0.56	0.23	0.55	0.55	0.42	0.55	0.19	0.53	0.12	0.55	0.53	0.25	0.10	0.53	1.00	0.65	0.52	0.40	0.56	0.59	0.66	0.58	0.28	0.43
30	0.63	0.56	0.48	0.43	0.20	0.56	0.49	0.42	0.44	0.48	0.53	0.41	0.34	0.59	0.50	0.47	0.46	0.48	0.45	0.57	0.44	0.66	0.28	0.60	0.44	0.48	0.38	0.45	0.65	1.00	0.55	0.30	0.65	0.44	0.46	0.69	0.15	0.53
31	0.70	0.53	0.58	0.51	0.27	0.44	0.52	0.51	0.64	0.52	0.53	0.72	0.48	0.57	0.66	0.35	0.59	0.44	0.58	0.64	0.40	0.67	0.35	0.68	0.52	0.32	0.42	0.46	0.52	0.55	1.00	0.43	0.49	0.48	0.58	0.60	0.27	0.52
32	0.47	0.29	0.43	0.27	0.49	0.01	0.44	0.26	0.45	0.42	0.31	0.49	0.38	0.38	0.45	0.01	0.43	0.21	0.34	0.34	0.32	0.39	0.31	0.35	0.46	0.39	0.30	0.46	0.40	0.30	0.43	1.00	0.26	0.46	0.51	0.41	0.22	0.48
33	0.52	0.65	0.45	0.47	0.28	0.49	0.33	0.54	0.39	0.49	0.66	0.33	0.39	0.49	0.63	0.40	0.50	0.53	0.47	0.60	0.35	0.53	0.18	0.49	0.55	0.30	0.34	0.62	0.56	0.65	0.49	0.26	1.00	0.47	0.64	0.77	0.23	0.48
34	0.44	0.45	0.38	0.41	0.38	0.30	0.47	0.59	0.55	0.33	0.53	0.43	0.48	0.58	0.65	0.13	0.50	0.62	0.43	0.49	0.37	0.40	0.27	0.59	0.47	0.33	0.06	0.47	0.49	0.44	0.48	0.46	0.47	1.00	0.65	0.51	0.30	0.30
35	0.50	0.68	0.53	0.59	0.32	0.31	0.38	0.54	0.53	0.47	0.56	0.43	0.60	0.45	0.71	0.10	0.57	0.63	0.54	0.59	0.10	0.46	0.16	0.64	0.56	0.27	0.20	0.69	0.66	0.46	0.58	0.51	0.64	0.65	1.00	0.70	0.19	0.37
36	0.55	0.70	0.59	0.55	0.41	0.56	0.47	0.58	0.53	0.55	0.66	0.51	0.32	0.59	0.72	0.28	0.56	0.51	0.57	0.69	0.29	0.62	0.30	0.57	0.61	0.58	0.47	0.60	0.58	0.69	0.60	0.41	0.77	0.51	0.70	1.00	0.27	0.63
37	0.17	0.42	0.15	0.16	0.34	-0.08	0.16	0.55	0.32	0.29	0.27	0.45	0.28	0.22	0.18	-0.01	0.32	0.17	0.26	0.28	0.29	0.36	0.22	0.16	0.38	0.08	0.23	0.02	0.28	0.15	0.27	0.22	0.23	0.30	0.19	0.27	1.00	0.37
38	0.49	0.53	0.55	0.40	0.48	0.34	0.40	0.48	0.51	0.59	0.30	0.55	0.27	0.44	0.53	0.37	0.51	0.28	0.38	0.59	0.27	0.55	0.28	0.45	0.58	0.45	0.52	0.41	0.43	0.53	0.52	0.48	0.48	0.30	0.37	0.63	0.37	1.00

Although the number of sorts (n = 38) in this correlation matrix increased from the one presented in chapter four, the number of statements, 43, did not change, making the formula for calculating significant correlations the same. Any value of ±0.39 is considered statistically significant, and these values are highlighted in Table 5-1. The numbers in the table are correlation coefficients, which refer "to the strength of a relationship between two variables" (Du Plessis, 2005, p. 162). In this case, the variables are the individual sorts. The correlation coefficient can range from +1 to -1. A +1 correlation coefficient (or 1.00) indicates full agreement and is rarely seen except when one variable is compared to itself, e.g. sort 3 and sort 3. A correlation coefficient of 0 indicates no relationship between the sorts. This only occurred between sorts 27 and 13, though there are many others whose correlation coefficients are close to 0, indicating little relationship. Correlation coefficients of -1 indicate complete disagreement. There were relatively few negative values in the sort, and all were closer to 0 than -1, indicating very slight disagreement and rendering them statistically insignificant. Sorts 5 and 6, 5 and 16, 6 and 37, 13 and 16, 16 and 37 all had negative correlation coefficients. Take, for example, sorts 5 and 6, and 5 and 16, which both had negative correlations. This does not mean that sorts 6 and 16 will reflect disagreement. In fact, the correlation coefficient between these two sorts is .51, which is considered statistically significant due to the fair amount of overlap between them.

The majority of the correlation coefficients in the matrix are positive values, indicating that there is a solid amount of agreement between the participants. Of the 1,444 total correlation coefficients, only 10 have negative values and two have correlation coefficients of 0, leaving 1,432 positive correlation coefficients. This means that 99.2% of the sorts have some level of agreement. Of these, 939 have values ±0.39 or greater, making them statistically significant. Therefore, 65% of all of the correlation coefficients have a statistically significant positive relationship, which indicates that there is a substantial amount of agreement among the participants. On average, each sort has a significant correlation to the others in 24 out of 38 sorts total, or 63% of the time. This makes sorts 5, 6, 16, 21, 23, 26, 27, and 37 stand out because of their low numbers of significant correlation to the other sorts. All of these sorts loaded onto at least one extracted factor (Table 5-2 in following section), which, along with the factor arrays (Table 5-4), will help explain this incongruity. Despite this, the majority of the participants shared common viewpoints about the blend of fictional literature with elementary science instruction. It is impossible to determine about what they are agreeing from the correlation matrix. Thus, further analysis is necessary.

Factor Matrix

Following the same procedure outlined in chapter four, I instructed the PQMethod software to extract the factors. I selected seven factors, following Watts' and Stenner's (2012) recommendation to extract one factor for every six participants in the study. Because there were 38 participants, seven factors were deemed appropriate.

Table 5-2: Factor matrix with an X indicating a defining sort

	Factor Loadings						
Sort	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**	**Factor 7**
1*	0.3362	0.1916	0.5844**X**	0.3418	0.2359	0.4012	-0.078
2*	0.6094**X**	0.3598	0.1667	0.1826	0.0709	-0.0212	0.4184
3*	0.4932	0.2184	0.4685	0.1989	0.1185	-0.0025	0.0385
4*	0.3125	0.3391	0.6497**X**	0.2559	0.1902	-0.1833	0.0606
5*	-0.0125	0.2218	0.2218	-0.1944	0.7099**X**	0.1915	0.2183
6	0.1227	0.3361	0.0931	0.7636**X**	0.035	0.0374	-0.1316
7	0.2946	0.0589	0.5745**X**	0.094	0.3443	0.4471	-0.034
8	0.2559	0.5407**X**	0.099	0.2225	0.0439	-0.096	0.6281**X**

9	0.4072	0.4081	0.2707	0.1002	-0.0292	0.4073	0.1867
10	0.3979	0.1147	0.4266	0.1862	0.4525	-0.0268	0.2326
11	0.6475**X**	0.4114	0.3545	0.0666	0.1211	0.1343	0.0461
12	0.4352	0.1397	0.4945	0.0136	0.1723	0.2046	0.4112
13	0.286	0.4248	0.6023**X**	-0.0809	-0.0504	-0.0851	0.2222
14	0.1267	0.3732	0.5793**X**	0.2754	0.33	0.2844	0.0984
15	0.5817**X**	0.563**X**	0.1179	0.1476	0.1603	0.0968	0.1207
16	-0.0115	-0.0692	0.1047	0.8429**X**	0.0747	0.0494	0.0631
17	0.5595**X**	0.2538	0.3621	0.2367	0.0322	0.1464	0.1653
18	0.3279	0.6638**X**	0.2215	0.1649	0.0438	0.0098	0.0483
19*	0.7721**X**	0.2026	0.2055	-0.083	0.1801	0.1683	0.0824
20*	0.2736	0.3906	0.3987	0.4777	0.2511	0.1037	0.1592
21	0.0741	0.0093	0.1359	0.0742	0.4365	0.7109**X**	0.1615
22	0.6409**X**	0.1273	0.2879	0.2695	0.064	0.4345	0.2306
23	0.0621	0.0902	0.0466	0.0869	-0.0849	0.7902**X**	0.0441
24	0.2005	0.4563	0.3954	0.4417	0.0665	0.2964	0.0188
25	0.7521**X**	0.1942	0.2705	0.102	0.1663	0.0514	0.2318
26	0.1629	0.1737	0.0405	0.2869	0.7435**X**	0.0936	-0.0741
27	0.3009	-0.2774	0.1896	0.348	0.5865**X**	0.2801	0.0661
28	0.6303**X**	0.4719	0.1452	0.143	0.1391	-0.0132	-0.2192
29	0.3558	0.5341**X**	0.2901	0.2043	0.0449	0.0597	0.2466
30	0.3674	0.3385	0.1821	0.5511**X**	0.223	0.2794	0.088
31	0.3814	0.2657	0.411	0.3464	0.0811	0.3478	0.199
32	0.1928	0.2793	0.2012	-0.1598	0.469	0.2451	0.0314
33	0.5251**X**	0.493	0.0207	0.3737	0.2544	0.069	0.1412
34	0.1177	0.7706**X**	0.2278	0.0171	0.1573	0.302	0.1627
35	0.4177	0.6979**X**	0.2308	0.0845	0.1678	-0.0123	0.039
36	0.53**X**	0.4524	0.0445	0.3954	0.4338	0.1014	0.1435
37	0.1369	0.0687	0.0786	-0.0843	0.1146	0.187	0.8599**X**
38	0.3349	0.0643	0.0947	0.404	0.4716	0.0809	0.3668
% Explained Variance	17	14	10	9	8	7	6

(indicates focus group participant)*

When the PQMethod program searched for factors, it looked for the largest portion of shared data, or agreement amongst the participants' distributions, which then became factor 1. To find factor 2, it searched for the next largest portion of shared data, and so on for each subsequent factor. Factor 1 accounts for 17% of the study variance, factor 2 for 14%, with each factor decreasing slightly down to factor 7, which accounts for 6% of the variance. Together, these seven factors account for 71% of the study variance. According to Watts and Stenner (2012), 35%-40% combined variance is considered sound, so 71% variance indicates a successful factor extraction.

Because the "basic function of a factor analysis is to account for as much of this study variance as is possible – i.e. to explain as much as we can about the relationships that hold between the many Q sorts in the group," (Watts & Stenner, 2012, p. 98) the factor extraction process is an important step in Q methodology. Each factor identifies "sizeable portions of common or shared meaning that are present in the data" (p. 98), and each factor will have its own configuration, which can be seen in the factor arrays in the following section. Negative values indicate sorts (participants' viewpoints) that are opposite the viewpoint represented by the factor. In this study, however, none of the negative values are considered statistically significant because they are all relatively close to 0. The closer a factor loading is to 1.00, the more strongly the sort exemplifies the factor. For example, sort 16 has a factor loading of 0.8429 on factor 4, which means it closely approximates that factor's viewpoint (Watts & Stenner, 2012).

To begin to make sense of each factor, one should look at the sorts that help define the factor, which are indicated by a value of ± 0.50 (Brown, 1993) and marked with an **X** in Table 5-2. Although the majority of the participants' sorts are unidentifiable, sorts one through five belong to Spenrico, Juniper, Sharon, Erin, and Tonya respectively, and sorts 19 and 20 belong to Alana and Patricia respectively. These participants' sorts are recognizable based on their participation in the focus groups, and their sorts are indicated with an asterisk in Table 5-2. Sharon and Patricia did not significantly load on any of the factors identified in the full group data analysis. The sorts that load on/define each factor are presented in Table 5-3, and the participants' Q sort distributions can be found in Appendix H.

Table 5-3: Factor defining Q sorts		
Factor	**Q sorts**	**Total**
1	2; 11; 17; 19; 22; 25; 28; 33; 36	9
2	18; 29; 34; 35	4
3	1; 4; 7; 13; 14	5
4	6; 16; 30	3
5	5; 26; 27	3
6	21; 23	2
7	37	1
Confounded	8; 15	2
Non-Significant	3; 9; 10; 12; 20; 24; 31; 32; 38	9

Table 5-3 accounts for all 38 sorts (one for each participant) in the study. Nine Q sorts exemplify factor 1, four sorts exemplify factor 2, and so on. Nine Q sorts are non-significant, meaning they do not exemplify any of the study's factors. The factor loadings for these sorts were between -0.5 and +0.5. Two Q sorts, 8 and 15, are confounded. Being confounded "means that it has significant factor loadings on more than one of the study factors" (Watts & Stenner, 2012, p. 130), and confounded Q sorts typically "are not used in the construction of any of the factor estimates" (p. 129). For example, as seen in Table 5-2, sort 15 had significant factor loadings of 0.5817 and 0.563 for factors 1 and 2 respectively. Because sort 15 loaded on both factors, it was removed from the list of sorts that exemplify the factor since the viewpoint represented in sort 15 is not unique to only one factor. The remaining Q sorts, 27 in all, are pure loadings, which means they significantly load on one factor only (Du Plessis, 2005). Though these sorts give an approximation of each factor, to fully understand what each factor represents one must examine the factor arrays. The researcher has discretion in choosing which factors are significant enough to interpret when the variance for specific factors is low (Du Plessis, 2005). I excluded factor 7 from the interpretation because, when the confounded sorts were removed, only one sort was left significantly loading on this factor. Because factors attempt to encapsulate shared viewpoints, having only one participants' sort does not contribute to a holistic picture.

Factor Arrays

According to Watts and Stenner (2012), factor arrays "form the basis of [the] factor interpretations" (p. 140). The arrays for each factor appear in Table 5-4 as well as in Figures 5-1 through 5-12. The figures are visual representations of the information in Table 5-4 that conform to the same distribution used by the participants.

Table 5-4: Factor Q sort values for each statement

		Factor Arrays						
Q Statements		**1**	**2**	**3**	**4**	**5**	**6**	**7**
1	Fictional literature and science both encourage students to think critically	2	2	2	-2	1	3	2
2	Fictional literature is beneficial in getting students excited about science	4	1	4	2	0	-3	-1
3	I have a limited background in using fictional literature to teach science	1	-1	0	-1	4	1	1
4	In order to use fictional literature to teach science, the teacher must know how to select books carefully	-1	-1	-1	4	4	4	3
5	Teachers used fictional literature in my science classes when I was in elementary school	-1	0	0	0	-1	0	1
6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning	-2	-2	-2	0	-1	0	-3
7	Fictional literature can be used to make science more approachable to youth	4	0	1	1	1	3	2

8	Fictional literature may lead to misconceptions about science if it adds too much fantasy	-2	-1	-1	3	2	0	-3
9	Fictional literature should be used during science instruction	3	1	-2	-1	-1	4	-2
10	Using fictional literature will increase students' science comprehension skills	1	1	0	-3	1	-1	0
11	I think that using fictional literature to teach science will get the children more engaged and interested in science	2	4	2	3	0	-1	2
12	Using fictional literature during science instruction will help elaborate on the concepts being taught	1	1	0	0	0	1	3
13	Fictional literature helps make a difficult science concept easier to understand	2	-1	2	0	1	1	0
14	Fictional literature uses science vocabulary that is more suited for children than non-fiction	0	-2	0	-1	-2	-4	4
15	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction	-3	-1	-2	-4	-2	2	0
16	Fictional literature should be used to teach science only if it includes actual facts with the story	-2	-1	-1	-1	-1	-2	0
17	Fictional literature helps teach the science TEKS	1	0	0	1	-1	0	-4
18	Fictional literature has the potential to increase both students' science knowledge and reading achievement	2	2	-1	2	1	3	1
19	I would like to know more about how to incorporate fictional literature into science teaching/learning	3	0	2	0	3	0	1
20	Fictional literature stimulates students' imagination and curiosity about science	1	1	3	0	2	1	-1
21	Fictional literature should be used to teach science because all subject areas are linked	-1	2	-1	2	-1	0	2
22	Fictional literature will help stimulate students' imagination about science	-1	0	1	2	3	-3	-2
23	Using fictional literature helps children get a better understanding of the science content	2	2	0	-3	0	-3	2
24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content	-2	-3	-3	-1	-3	-2	0
25	Using fictional literature helps students access their prior knowledge	0	3	0	-1	3	2	4
26	Using fictional literature will help students connect to the science content more easily	0	1	3	4	-2	-2	-1
27	Fictional literature will create too many misconceptions to make it a useful teaching tool for science	-4	-2	-3	1	-1	-2	-1
28	Non-fictional literature should be used more than fictional literature in science instruction	-1	-2	-2	2	-3	1	-2
29	Using fictional literature will make science more relatable to students	0	0	2	3	-3	1	1
30	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts	0	3	4	0	0	1	1
31	The accuracy of science content suffers in fictional literature	-1	-3	-1	-1	0	0	0
32	Reading books is an important part of science instruction	-1	2	1	1	2	-1	-2

33	Fictional literature should not be used during instruction because science is based on factual information	-4	-4	-3	-4	-4	-1	-1
34	There is a time for fictional literature in elementary instruction, just not in science	-3	-3	-2	1	-2	-2	-1
35	Using fictional literature encourages students to make predictions, which is an important skill in science	0	4	0	0	0	0	-1
36	Using fictional literature broadens the range of science content to which students are exposed	0	0	1	1	2	-1	-3
37	There is a lack of understanding about how fictional literature can be used to support science instruction	-1	0	1	1	0	2	-2
38	Students will have a difficult time transferring science information from a fictional setting to a real-world one	-3	-2	-4	-2	0	-1	0
39	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts	1	3	1	-2	1	2	1
40	Fictional literature will help students acquire scientific habits of mind	0	1	-1	-2	1	0	0
41	Fictional literature should be used more as a teaching tool in science	1	0	3	-2	-2	-1	0
42	Fictional literature is underutilized in science instruction	3	-1	1	0	2	2	3
43	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science	-2	-4	-4	-3	-4	-4	-4

Although few generalizations can be made about the statements themselves when examining the factor arrays, a few things stand out in Table 5-4. Across all seven factors, which represent various combinations of participants' viewpoints, there is strong disagreement with statement 43 (Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science). In fact, in five of the factors, this statement was ranked at a -4, indicating the highest level of disagreement. Another statement with similar results is 33 (Fictional literature should not be used during instruction because science is based on factual information). There was disagreement with this statement across all seven factors, with a -4 ranking in four of them. No other statements have such strong congruence across the factors, whether strongly agreeing or strongly disagreeing. The participants were more aligned in their disagreement than in their agreement with any of the statements.

In the following sections, the information for each factor is presented in two formats followed by an interpretation of the factor. In each section, the factor array first is shown in the form of a distribution, and second in the form of a list with the inclusion of the statements the participants sorted. To conduct the interpretation, I followed the same procedure outlined in chapter four. According to Watts and Stenner (2012), "a good factor interpretation should capture, draw out, and communicate… the preferences, likes and dislikes—of its participants" (p. 158). In Figures 5-2, 5-4, 5-6, 5-8, 5-10, and 5-12, I made note of the statements that were ranked higher than in any other factor array by using a Δ symbol, or lower by using a ∇ symbol. For example, in factor 2, statement 7 is ranked at a 0 (neutral). Statement 7 has no other rankings lower than that among any of the other factors, so it is marked with a ∇. This indicates that there is more disagreement with this statement in this factor than in any others, even though it appears to be a neutral statement if the researcher only looks at factor 2.

Examining the statements from this perspective is advantageous because it enables the researcher to "identify items of potential importance ranked towards the middle or zero point of the distribution" (Watts & Stenner, 2012, p. 154). Although statements in this range of the distribution often are indicative of neutrality, the goal of a factor interpretation is to provide a "full and holistic" (p. 155) picture of the viewpoint represented by the factor, and that includes the identification of any noteworthy zero or near-zero rankings. Organizing the statements in this way allows for the identification of "those important issues about which the factor viewpoint is polarized, and… how that viewpoint is polarized relative to the other study factors" (p. 153). I did not flag the statements in chapter four because, with only two factors, this information is readily apparent in the factor array table. In this chapter, I continued to use the narrative style of interpretation. When a focus group participant loaded on a particular factor, I used his/her reflections to support the interpretation.

Interpretation of factor 1: It works, now tell me more. Factor 1 accounts for 17% of the study's variance (Table 5-2). Therefore, it is representative of the largest portion of the participants' shared viewpoints about integrating fictional literature and science. Juniper (sort 2, 0.6094 factor loading) and Alana (sort 19, 0.7721 factor loading) significantly loaded on this factor, along with sorts 11, 17, 22, 25, 28, 33, and 36. Sort 15 did as well, but it was confounded and therefore removed from the list. That left nine sorts that loaded on factor 1.

-4				0				+4
27	15	6	4	14	3	1	9	2
33	34	8	5	21	10	11	19	7
	38	16	22	25	12	13	42	
		24	28	26	17	18		
		43	31	29	20	23		
			32	30	39			
			37	35	41			
				36				
				40				

Figure 5-1: Factor 1 distribution

As seen in Figure 5-2, the following statements were ranked higher (more agreement) in factor 1 than in any other factor:

7) Fictional literature can be used to make science more approachable to youth (+4)

42) Fictional literature is underutilized in science instruction (+3)

43) Using fictional literature during science instruction will cause students who

dislike language arts to become less interested in science (-2)

The following statements were ranked lower (more disagreement) in factor 1 than in any other factor:

8) Fictional literature may lead to misconceptions about science if it adds too much fantasy (-2)

27) Fictional literature will create too many misconceptions to make it a useful teaching tool for science (-4)

FACTOR 1

Items Ranked at +4

2	Fictional literature is beneficial in getting students excited about science
7Δ	Fictional literature can be used to make science more approachable to youth

Items Ranked at +3

9	Fictional literature should be used during science instruction
19	I would like to know more about how to incorporate fictional literature into science teaching/learning
42Δ	Fictional literature is underutilized in science instruction

Items Ranked at +2

1	Fictional literature and science both encourage students to think critically
11	I think that using fictional literature to teach science will get the children more engaged and interested in science
13	Fictional literature helps make a difficult science concept easier to understand
18	Fictional literature has the potential to increase both students' science knowledge and reading achievement
23	Using fictional literature helps children get a better understanding of the science content

Items Ranked at +1

3	I have a limited background in using fictional literature to teach science
10	Using fictional literature will increase students' science comprehension skills
12	Using fictional literature during science instruction will help elaborate on the concepts being taught
17	Fictional literature helps teach the science TEKS
20	Fictional literature stimulates students' imagination and curiosity about science
39	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts
41	Fictional literature should be used more as a teaching tool in science

Figure 5-2: Factor 1 statements organized by placement on distribution sheet

Items Ranked at 0

14	Fictional literature uses science vocabulary that is more suited for children than non-fiction
21	Fictional literature should be used to teach science because all subject areas are linked
25	Using fictional literature helps students access their prior knowledge
26	Using fictional literature will help students connect to the science content more easily
29	Using fictional literature will make science more relatable to students
30	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts
35	Using fictional literature encourages students to make predictions, which is an important skill in science
36	Using fictional literature broadens the range of science content to which students are exposed
40	Fictional literature will help students acquire scientific habits of mind

Items Ranked at -1

4	In order to use fictional literature to teach science, the teacher must know how to select books carefully
5	Teachers used fictional literature in my science classes when I was in elementary school
22	Fictional literature will help stimulate students' imagination about science
28	Non-fictional literature should be used more than fictional literature in science instruction
31	The accuracy of science content suffers in fictional literature
32	Reading books is an important part of science instruction
37∇	There is a lack of understanding about how fictional literature can be used to support science instruction

Items Ranked at -2

6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning
8∇	Fictional literature may lead to misconceptions about science if it adds too much fantasy
16	Fictional literature should be used to teach science only if it includes actual facts with the story
24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content
43Δ	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science

Items Ranked at -3

15	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
34	There is a time for fictional literature in elementary instruction, just not in science
38	Students will have a difficult time transferring science information from a fictional setting to a real-world one

Items Ranked at -4

27∇	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
33	Fictional literature should not be used during instruction because science is based on factual information

Figure 5-2 cont.

This factor is titled *It works, now tell me more* because there is strong evidence among participants that fictional literature should be used during science instruction (9: +3) due to its ability to get students excited about science (2: +4) and make science more approachable (7: +4). Additionally, the added benefits of using literature in conjunction with science instruction as a tool to encourage students to think critically (1: +2), aid in comprehension (13: +2; 23: +2), and increase achievement in both science and language arts (18: +2) are acknowledged. There is ample recognition that fictional literature has a place in science instruction (33: -4; 34, +3), with Juniper stating that someone thinking fictional literature does not belong in science is “mind blowing… because fictional literature is used for so much.” Despite the fantasy nature of some fictional literature, it is unlikely to cause misconceptions (8: -2) and students will not have trouble identifying the factual information (38: -3).

This factor shows that literature is underutilized in science instruction (42: +3) more than in any other factor, perhaps contributing to the desire to know more about how fictional literature can be blended with science teaching and learning (19: +3). However, there is slight disagreement with there being a lack of understanding about how fictional literature can support science instruction (37: -1). Alana reconciled these two seemingly contradictory ideas by stating, “more practice wouldn’t hurt, but I think I could go out there and do it now.” In the viewpoint expressed by this factor, it is just as easy to find fictional literature that connects to the science TEKS than it is to find non-fiction (15: -3), making it equally useful, if not more so. For Alana, “it really depends [on] what science book you choose from ‘cuz some can be really—some can be too factual, where it’s just boring.”

Interpretation of factor 2: Been there, done that. Factor 2 accounts for 14% of the study's variance (Table 5-2). It is the second largest approximation of the participants' viewpoints. None of the focus group participants significantly loaded on this factor. Sorts 18, 29, 34, and 35 significantly loaded on this factor. Sorts 8 and 15 did as well, but they were both confounded with other factors so they were removed from the list of sorts that characterize factor 2, leaving four sorts that loaded on factor 2.

-4				0				+4
33	24	6	3	5	2	1	25	11
43	31	14	4	7	9	18	30	35
	34	27	8	17	10	21	39	
		28	13	19	12	23		
		38	15	22	20	32		
			16	29	26			
			42	36	40			
				37				
				41				

Figure 5-3: Factor 2 distribution

As seen in Figure 5-4, the following statements were ranked higher in factor 2 than in any other factor:

11) I think that using fictional literature to teach science will get the children more engaged and interested in science (+4)

35) Using fictional literature encourages students to make predictions, which is an important skill in science (+4)

39) Fictional literature provides a foundation on which to build and develop students' understanding of science concepts (+3)

The following statements were ranked lower in factor 2 than in any other factor:

7) Fictional literature can be used to make science more approachable to youth (0)

13) Fictional literature helps make a difficult science concept easier to understand (-1)

42) Fictional literature is underutilized in science instruction (-1)

FACTOR 2

Items Ranked at +4

11Δ	I think that using fictional literature to teach science will get the children more engaged and interested in science
35Δ	Using fictional literature encourages students to make predictions, which is an important skill in science

Items Ranked at +3

25	Using fictional literature helps students access their prior knowledge
30	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts
39Δ	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts

Items Ranked at +2

1	Fictional literature and science both encourage students to think critically
18	Fictional literature has the potential to increase both students' science knowledge and reading achievement
21	Fictional literature should be used to teach science because all subject areas are linked
23	Using fictional literature helps children get a better understanding of the science content
32	Reading books is an important part of science instruction

Items Ranked at +1

2	Fictional literature is beneficial in getting students excited about science
9	Fictional literature should be used during science instruction
10	Using fictional literature will increase students' science comprehension skills
12	Using fictional literature during science instruction will help elaborate on the concepts being taught
20	Fictional literature stimulates students' imagination and curiosity about science
26	Using fictional literature will help students connect to the science content more easily
40	Fictional literature will help students acquire scientific habits of mind

Items Ranked at 0

5	Teachers used fictional literature in my science classes when I was in elementary school

Figure 5-4: Factor 2 statements organized by placement on distribution sheet

7∇	Fictional literature can be used to make science more approachable to youth
17	Fictional literature helps teach the science TEKS
19	I would like to know more about how to incorporate fictional literature into science teaching/learning
22	Fictional literature will help stimulate students' imagination about science
29	Using fictional literature will make science more relatable to students
36	Using fictional literature broadens the range of science content to which students are exposed
37	There is a lack of understanding about how fictional literature can be used to support science instruction
41	Fictional literature should be used more as a teaching tool in science

Items Ranked at -1

3	I have a limited background in using fictional literature to teach science
4	In order to use fictional literature to teach science, the teacher must know how to select books carefully
8	Fictional literature may lead to misconceptions about science if it adds too much fantasy
13∇	Fictional literature helps make a difficult science concept easier to understand
15	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
16	Fictional literature should be used to teach science only if it includes actual facts with the story
42∇	Fictional literature is underutilized in science instruction

Items Ranked at -2

6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning
14	Fictional literature uses science vocabulary that is more suited for children than non-fiction
27	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
28	Non-fictional literature should be used more than fictional literature in science instruction
38	Students will have a difficult time transferring science information from a fictional setting to a real-world one

Items Ranked at -3

24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content
31∇	The accuracy of science content suffers in fictional literature
34	There is a time for fictional literature in elementary instruction, just not in science

Items Ranked at -4

33	Fictional literature should not be used during instruction because science is based on factual information
43	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science

Figure 5-4 cont.

Factor 2 is titled *Been there, done that.* This factor demonstrates the strong recognition of the usefulness of fictional literature during science instruction (34: -3). However, as opposed to other factors, the belief is that it is already being used as a teaching tool in science (42: -1) and does not need to be used more (41: 0), perhaps owing to there being some background knowledge about how stories and science blend together (3: -1). This does not mean that using fictional literature is discounted as an important teaching strategy. On the contrary, in this factor there is recognition of the shared cognitive processes, skills and strategies employed in both language arts and science. Through the use of fictional literature, students are encouraged to make predictions, which is an important skill in both science (35: +4) and language arts. Additionally, the use of fictional literature provides a foundation on which to develop students' understanding of science concepts (39: +3). Using fictional literature has the added benefits of building interest in and engagement with science (11: +4) as well as helping students access prior knowledge (25: +3), making it an important part of science instruction (32: +2). Because science does not need to be presented solely as a set of facts (33: -4), the accuracy of science content does not diminish simply because it is presented in story form (31: -3).

Interpretation of factor 3: A walking contradiction. Factor 3 accounts for 10% of the study's variance (Table 5-2). Spenrico (sort 1, 0.5844 factor loading) and Erin (sort 4, 0.6497 factor loading) significantly loaded on this factor, along with sorts 7, 13, and 14. In all, five sorts had pure loadings on factor 3.

-4				0				+4
38	24	6	4	3	7	1	20	2
43	27	9	8	5	22	11	26	30
	33	15	16	10	32	13	41	
		28	18	12	36	19		
		34	21	14	37	29		
			31	17	39			
			40	23	42			
				25				
				35				

Figure 5-5: Factor 3 distribution

As seen in Figure 5-6 below, the following statements were ranked higher in factor 3 than in any other factor:

30) Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts (+4)

20) Fictional literature stimulates students' imagination and curiosity about science (+3)

41) Fictional literature should be used more as a teaching tool in science (+3)

The following statements were ranked lower in factor 3 than in any other factor:

18) Fictional literature has the potential to increase both students' science knowledge and reading achievement (-1)

9) Fictional literature should be used during science instruction (-2)

38) Students will have a difficult time transferring science information from a fictional setting to a real-world one (-4)

FACTOR 3

Items Ranked at +4

2	Fictional literature is beneficial in getting students excited about science
30Δ	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts

Items Ranked at +3

20Δ	Fictional literature stimulates students' imagination and curiosity about science
26	Using fictional literature will help students connect to the science content more easily
41Δ	Fictional literature should be used more as a teaching tool in science

Items Ranked at +2

1	Fictional literature and science both encourage students to think critically
11	I think that using fictional literature to teach science will get the children more engaged and interested in science
13	Fictional literature helps make a difficult science concept easier to understand
19	I would like to know more about how to incorporate fictional literature into science teaching/learning
29	Using fictional literature will make science more relatable to students

Items Ranked at +1

7	Fictional literature can be used to make science more approachable to youth
22	Fictional literature will help stimulate students' imagination about science
32	Reading books is an important part of science instruction
36	Using fictional literature broadens the range of science content to which students are exposed
37	There is a lack of understanding about how fictional literature can be used to support science instruction
39	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts
42	Fictional literature is underutilized in science instruction

Items Ranked at 0

3	I have a limited background in using fictional literature to teach science
5	Teachers used fictional literature in my science classes when I was in elementary school
10	Using fictional literature will increase students' science comprehension skills
12	Using fictional literature during science instruction will help elaborate on the concepts being taught
14	Fictional literature uses science vocabulary that is more suited for children than non-fiction
17	Fictional literature helps teach the science TEKS
23	Using fictional literature helps children get a better understanding of the science content
25	Using fictional literature helps students access their prior knowledge
35	Using fictional literature encourages students to make predictions, which is an important skill in science

Figure 5-6: Factor 3 statements organized by placement on distribution sheet

Items Ranked at -1	
4	In order to use fictional literature to teach science, the teacher must know how to select books carefully
8	Fictional literature may lead to misconceptions about science if it adds too much fantasy
16	Fictional literature should be used to teach science only if it includes actual facts with the story
18∇	Fictional literature has the potential to increase both students' science knowledge and reading achievement
21	Fictional literature should be used to teach science because all subject areas are linked
31	The accuracy of science content suffers in fictional literature
40	Fictional literature will help students acquire scientific habits of mind
Items Ranked at -2	
6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning
9∇	Fictional literature should be used during science instruction
15	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
28	Non-fictional literature should be used more than fictional literature in science instruction
34	There is a time for fictional literature in elementary instruction, just not in science
Items Ranked at -3	
24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content
27	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
33	Fictional literature should not be used during instruction because science is based on factual information
Items Ranked at -4	
38∇	Students will have a difficult time transferring science information from a fictional setting to a real-world one
43	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science

Figure 5-6 cont.

Factor 3 is titled *A walking contradiction* because of its opposite placement of two very closely worded statements and perspectives. There was strong agreement that fictional literature should be used more as a teaching tool in science (41: +3); in fact, this was the highest ranking out of all six factors. Oddly, there was disagreement that fictional literature should be used during science instruction (9: -2). This was the lowest ranking out of all six factors, leaving the reader with two very strong perspectives on the same topic that are in opposition to each other. The other statements' placements as well as Spenrico's and Erin's thoughts help shed some light on what the prevailing perspective might be.

As explained by Erin, there is a place for fictional literature in science instruction (34: -2):

> [Books] get to [students'] level instead of just throwing facts at them. They get the facts with a story that they can relate to and visually see in their head and grasp onto that real concept instead of just focusing on 'I have to memorize this for my test.'

Fictional literature is useful because stories enable students to better connect with the science content (26: +3) as well as understand it (13: +2), and help get them excited about it (2: +4). There is little chance that students will get so swept up in the story that they might miss the science content (24: -3). According to Spenrico, the "responsibility [to clarify content] falls mostly on the shoulders of the teacher [and] how they present the fictional literature."

It's possible the contradiction might be attributed to the need to know more about how to incorporate fictional literature into science teaching and learning (19: +2) and a lack of understanding about how fictional literature can be used to support science instruction (37: +1), or that the wording of the statements may have confused some participants.

Interpretation of factor 4: No thanks. Factor 4 accounts for 9% of the study's variance (Table 5-2). None of the focus group participants significantly loaded on this factor. Three sorts—6, 16, and 30—had pure loadings on this factor.

-4				0				+4
15	10	1	3	5	7	2	8	4
33	23	38	9	6	17	18	11	26
	43	39	14	12	27	21	29	
		40	16	13	32	22		
		41	24	19	34	28		
			25	20	36			
			31	30	37			
				35				
				42				

Figure 5-7: Factor 4 distribution

As seen in Figure 5-8, the following statements were ranked higher in factor 4 than in any other factor:

26) Using fictional literature will help students connect to the science content more easily (+4)

8) Fictional literature may lead to misconceptions about science if it adds too much fantasy (+3)

29) Using fictional literature will make science more relatable to students (+3)

27) Fictional literature will create too many misconceptions to make it a useful teaching tool for science (+1)

34) There is a time for fictional literature in elementary instruction, just not in science (+1)

24) Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content (-1)

The following statements were ranked lower in factor 4 than in any other factor:

20) Fictional literature stimulates students' imagination and curiosity about

science (0)

25) Using fictional literature helps students access their prior knowledge (-1)

39) Fictional literature provides a foundation on which to build and develop students' understanding of science concepts (-2)

40) Fictional literature will help students acquire scientific habits of mind (-2)

10) Using fictional literature will increase students' science comprehension skills (-3)

15) It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction (-4)

FACTOR 4	
Items Ranked at +4	
4	In order to use fictional literature to teach science, the teacher must know how to select books carefully
26Δ	Using fictional literature will help students connect to the science content more easily
Items Ranked at +3	
8Δ	Fictional literature may lead to misconceptions about science if it adds too much fantasy
11	I think that using fictional literature to teach science will get the children more engaged and interested in science
29Δ	Using fictional literature will make science more relatable to students
Items Ranked at +2	
2	Fictional literature is beneficial in getting students excited about science
18	Fictional literature has the potential to increase both students' science knowledge and reading achievement
21	Fictional literature should be used to teach science because all subject areas are linked
22	Fictional literature will help stimulate students' imagination about science
28	Non-fictional literature should be used more than fictional literature in science instruction
Items Ranked at +1	
7	Fictional literature can be used to make science more approachable to youth
17	Fictional literature helps teach the science TEKS
27Δ	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
32	Reading books is an important part of science instruction

Figure 5-8: Factor 4 statements organized by placement on distribution sheet

34∆ There is a time for fictional literature in elementary instruction, just not in science

36 Using fictional literature broadens the range of science content to which students are exposed

37 There is a lack of understanding about how fictional literature can be used to support science instruction

Items Ranked at 0

5 Teachers used fictional literature in my science classes when I was in elementary school

6 When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning

12 Using fictional literature during science instruction will help elaborate on the concepts being taught

13 Fictional literature helps make a difficult science concept easier to understand

19 I would like to know more about how to incorporate fictional literature into science teaching/learning

20∇ Fictional literature stimulates students' imagination and curiosity about science

30 Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts

35 Using fictional literature encourages students to make predictions, which is an important skill in science

42 Fictional literature is underutilized in science instruction

Items Ranked at -1

3 I have a limited background in using fictional literature to teach science

9 Fictional literature should be used during science instruction

14 Fictional literature uses science vocabulary that is more suited for children than non-fiction

16 Fictional literature should be used to teach science only if it includes actual facts with the story

24∆ Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content

25∇ Using fictional literature helps students access their prior knowledge

31 The accuracy of science content suffers in fictional literature

Items Ranked at -2

1 Fictional literature and science both encourage students to think critically

38 Students will have a difficult time transferring science information from a fictional setting to a real-world one

39∇ Fictional literature provides a foundation on which to build and develop students' understanding of science concepts

40∇ Fictional literature will help students acquire scientific habits of mind

41 Fictional literature should be used more as a teaching tool in science

Items Ranked at -3

10∇ Using fictional literature will increase students' science comprehension skills

23 Using fictional literature helps children get a better understanding of the science content

43 Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science

Figure 5-8 cont.

Items Ranked at -4	
15∇	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
33	Fictional literature should not be used during instruction because science is based on factual information

Figure 5-8 cont.

Factor 4 is titled *No thanks.* Although there is some acknowledgement of the benefits of blending fictional literature and science, such as making science more relatable (29: +3) and helping students connect to the content (26, +4), there were more concerns expressed about the use of fictional literature in this factor than in any other. Despite its potential to increase both students' science knowledge and reading achievement (18: +2), the time for using fictional literature in elementary instruction primarily is not during science (34: +2). There is concern that fictional literature will create too many misconceptions to make it a useful teaching tool (27: +1). These misconceptions might prevent students from getting a clear understanding of the science content (23: -3). Even though fictional literature helps teach the science TEKS (17: +1), non-fictional literature should be used more than fictional literature in science instruction (28: +2). Although difficult to pinpoint exactly from where these concerns about using fictional literature stem, it is possible that limited backgrounds in using fictional literature (3: -1) contribute to a lack of knowledge about how to select fictional books for teaching science, which is seen as an important skill that requires great care (4: +4).

Interpretation of factor 5: Learn from the past. Factor 5 accounts for eight percent of the study's variance (Table 5-2). Tonya (sort 5, 0.7099 factor loading) significantly loaded on this factor, along with sorts 26 and 27; all were pure loadings.

-4				0				+4
33	24	14	5	2	1	8	19	3
43	28	15	6	11	7	20	22	4
	29	26	9	12	10	32	25	
		34	16	23	13	36		
		41	17	30	18	42		
			21	31	39			
			27	35	40			
				37				
				38				

Figure 5-9: Factor 5 distribution

As seen in Figure 5-10 below, the following statements were ranked higher in factor 5 than in any other factor:

22) Fictional literature will help stimulate students' imagination about science (+3)

36) Using fictional literature broadens the range of science content to which students are exposed (+2)

38) Students will have a difficult time transferring science information from fictional setting to a real-world one (0)

The following statements were ranked lower in factor 5 than in any other factor:

17) Fictional literature helps teach the science TEKS (-1)

28) Non-fictional literature should be used more than fictional literature in science Instruction (-3)

29) Using fictional literature will make science more relatable to students (-3)

FACTOR 5

Items Ranked at +4

3 I have a limited background in using fictional literature to teach science

Figure 5-10: Factor 5 statements organized by placement on distribution sheet

4	In order to use fictional literature to teach science, the teacher must know how to select books carefully

Items Ranked at +3

19	I would like to know more about how to incorporate fictional literature into science teaching/learning
22Δ	Fictional literature will help stimulate students' imagination about science
25	Using fictional literature helps students access their prior knowledge

Items Ranked at +2

8	Fictional literature may lead to misconceptions about science if it adds too much fantasy
20	Fictional literature stimulates students' imagination and curiosity about science
32	Reading books is an important part of science instruction
36Δ	Using fictional literature broadens the range of science content to which students are exposed
42	Fictional literature is underutilized in science instruction

Items Ranked at +1

1	Fictional literature and science both encourage students to think critically
7	Fictional literature can be used to make science more approachable to youth
10	Using fictional literature will increase students' science comprehension skills
13	Fictional literature helps make a difficult science concept easier to understand
18	Fictional literature has the potential to increase both students' science knowledge and reading achievement
39	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts
40	Fictional literature will help students acquire scientific habits of mind

Items Ranked at 0

2	Fictional literature is beneficial in getting students excited about science
11	I think that using fictional literature to teach science will get the children more engaged and interested in science
12	Using fictional literature during science instruction will help elaborate on the concepts being taught
23	Using fictional literature helps children get a better understanding of the science content
30	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts
31	The accuracy of science content suffers in fictional literature
35	Using fictional literature encourages students to make predictions, which is an important skill in science
37	There is a lack of understanding about how fictional literature can be used to support science instruction
38Δ	Students will have a difficult time transferring science information from a fictional setting to a real-world one

Figure 5-10 cont.

Items Ranked at -1	
5	Teachers used fictional literature in my science classes when I was in elementary school
6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning
9	Fictional literature should be used during science instruction
16	Fictional literature should be used to teach science only if it includes actual facts with the story
17∇	Fictional literature helps teach the science TEKS
21	Fictional literature should be used to teach science because all subject areas are linked
27	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
Items Ranked at -2	
14	Fictional literature uses science vocabulary that is more suited for children than non-fiction
15	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
26	Using fictional literature will help students connect to the science content more easily
34	There is a time for fictional literature in elementary instruction, just not in science
41	Fictional literature should be used more as a teaching tool in science
Items Ranked at -3	
24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content
28∇	Non-fictional literature should be used more than fictional literature in science instruction
29∇	Using fictional literature will make science more relatable to students
Items Ranked at -4	
33	Fictional literature should not be used during instruction because science is based on factual information
43	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science

Figure 5-10 cont.

Factor 5 is titled *Learn from the past* because the lack of use of fictional literature during elementary school instruction in the past (5: -1) affected the perspective that there is a collective limited background in using fictional literature to teach science (3: +4). Considering the lack of modeling of the integration of fictional literature in science instruction in the past schooling experiences of participants, there was a desire to learn more about how to blend fictional literature with science teaching and learning (19: +3). It was likely that part of this desire came from the perception that teachers must know how to select fictional literature carefully (4: +4) in order not to lead to misconceptions about the science content in their students (8: +2).

When appropriate books are selected, it broadens the range of content to which students are exposed (36: +6) and stimulates students' imagination about science (22: +3). According to Tonya, "books make [science] kid friendly" and "give it more like a fun factor." Because it makes difficult concepts easier to understand (13: +1), reading fictional literature is an important part of science instruction (32: +2) that is currently underutilized (42: +2). There is strong disagreement that non-fictional literature has more of a place in science instruction than fictional literature (28: +2). According to Tonya, "that's just one way—textbook—but when you pull in fictional literature, it's like all different types of stories." Although these stories may not have vocabulary that is more relatable than in non-fiction (14: -2), fictional literature will help increase students' science comprehension skills (13: +1).

Interpretation of factor 6: Academics trump imagination. Factor 6 accounts for seven percent of the study's variance (Table 5-2). None of the focus group participants significantly loaded on this factor. In all, two sorts—21 and 23, had pure loadings on factor 6.

-4				0				+4
14	2	16	10	5	3	15	1	4
43	22	24	11	6	12	25	7	9
	23	26	32	8	13	37	18	
		27	33	17	20	39		
		34	36	19	28	42		
			38	21	29			
			41	31	30			
				35				
				40				

Figure 5-11: Factor 6 distribution

As seen in Figure 5-12, the following statements were ranked higher in factor 6 than in any other factor:

9) Fictional literature should be used during science instruction (+4)

1) Fictional literature and science both encourage students to think critically (+3)

18) Fictional literature has the potential to increase both students' science knowledge and reading achievement (+3)

15) It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction (+2)

37) There is a lack of understanding about how fictional literature can be used to support science instruction (+2)

28) Non-fictional literature should be used more than fictional literature in science instruction (+1)

33) Fictional literature should not be used during instruction because science is based on factual information (-1)

The following statements were ranked lower in factor 6 than in any other factor:

11) I think that using fictional literature to teach science will get the children more engaged and interested in science (-1)

36) Using fictional literature broadens the range of science content to which students are exposed (-1)

2) Fictional literature is beneficial in getting students excited about science (-3)

22) Fictional literature will help stimulate students' imagination about science (-3)

14) Fictional literature uses science vocabulary that is more suited for children than non-fiction (-4)

FACTOR 6	
Items Ranked at +4	
4	In order to use fictional literature to teach science, the teacher must know how to select books carefully
9Δ	Fictional literature should be used during science instruction
Items Ranked at +3	
1Δ	Fictional literature and science both encourage students to think critically
7	Fictional literature can be used to make science more approachable to youth
18Δ	Fictional literature has the potential to increase both students' science knowledge and reading achievement
Items Ranked at +2	
15Δ	It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction
25	Using fictional literature helps students access their prior knowledge
37Δ	There is a lack of understanding about how fictional literature can be used to support science instruction
39	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts
42	Fictional literature is underutilized in science instruction
Items Ranked at +1	
3	I have a limited background in using fictional literature to teach science
12	Using fictional literature during science instruction will help elaborate on the concepts being taught
13	Fictional literature helps make a difficult science concept easier to understand
20	Fictional literature stimulates students' imagination and curiosity about science

Figure 5-12: Factor 6 statements organized by placement on distribution sheet

28∆	Non-fictional literature should be used more than fictional literature in science instruction
29	Using fictional literature will make science more relatable to students
30	Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts

Items Ranked at 0

5	Teachers used fictional literature in my science classes when I was in elementary school
6	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning
8	Fictional literature may lead to misconceptions about science if it adds too much fantasy
17	Fictional literature helps teach the science TEKS
19	I would like to know more about how to incorporate fictional literature into science teaching/learning
21	Fictional literature should be used to teach science because all subject areas are linked
31	The accuracy of science content suffers in fictional literature
35	Using fictional literature encourages students to make predictions, which is an important skill in science
40	Fictional literature will help students acquire scientific habits of mind

Items Ranked at -1

10	Using fictional literature will increase students' science comprehension skills
11∇	I think that using fictional literature to teach science will get the children more engaged and interested in science
32	Reading books is an important part of science instruction
33∆	Fictional literature should not be used during instruction because science is based on factual information
36∇	Using fictional literature broadens the range of science content to which students are exposed
38	Students will have a difficult time transferring science information from a fictional setting to a real-world one
41	Fictional literature should be used more as a teaching tool in science

Items Ranked at -2

16	Fictional literature should be used to teach science only if it includes actual facts with the story
24	Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content
26	Using fictional literature will help students connect to the science content more easily
27	Fictional literature will create too many misconceptions to make it a useful teaching tool for science
34	There is a time for fictional literature in elementary instruction, just not in science

Items Ranked at -3

2∇	Fictional literature is beneficial in getting students excited about science
22∇	Fictional literature will help stimulate students' imagination about science
23	Using fictional literature helps children get a better understanding of the science content

Figure 5-12 cont.

Items Ranked at -4	
14∇	Fictional literature uses science vocabulary that is more suited for children than non-fiction
43	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science

Figure 5-12 cont.

Factor 6 is titled *Academics trump imagination*. First and foremost, there is strong recognition that fictional literature has a place and should be used in elementary science instruction (9: +4), although there is some debate over the balance between non-fiction and fiction in science (28: +1). To use fiction as a teaching tool in science, teachers must know how to select appropriate books carefully (4: +4). This partly stems from the view that it is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction (15: +2). This may be a factor in the lack of understanding about how fictional literature can be used to support science instruction (37: +2).

Despite these issues, the viewpoint expressed in this factor is that fictional literature is not used enough in elementary science (42: +2). Because it has the potential to increase both students' science knowledge and reading achievement (18: +3), it is an important tool. It encourages students to think critically about science (1: +3), helps students tap into their prior knowledge (25: +2), and provides a foundation on which to build and develop students' understanding of science concepts (39: +2). There are many academic benefits to be gained through incorporating fictional literature into elementary science instruction. Of less importance is the potential emotional connection to science that stories might develop in students. Using fictional literature will neither get students excited about science (2: -3), nor will it stimulate their imagination (22: -3).

Conclusion

Chapter five started with an overview of the participants in this study. Their individual viewpoints in the form of their distributions were included in Appendix H. The correlation matrix, factor matrix, and factor arrays were displayed, along with an interpretation of each factor. Although I instructed the PQMethod program to extract seven factors, I dismissed the seventh one because it was not representative of participants' shared viewpoints. At the conclusion of the factor extraction process, 38 individual Q sorts now have been effectively reduced to six, presented in the form of factors. From the interpretations, I determined the key findings of the study, which are presented in chapter six.

VI. DISCUSSION AND IMPLICATIONS

This study examined the perceptions of TCs at a diverse four-year university regarding the use of fictional literature in elementary science instruction. The TCs were undergraduate students enrolled in my two elementary science methods classes during the summer of 2016. As part of our classwork leading into our discussion of interdisciplinary work in science, students performed a card sort to put items into categories, an activity we had discussed as beneficial for use with elementary-aged students. Though the TCs' card sort was much more advanced than would be a card sort for elementary children, the principle of doing a card sort was the same, and the TCs sorted a set of 43 statements into agree, disagree, and neutral piles, than ranked them using a distribution sheet. Thirty TC students volunteered to be participants in this study, and seven of those participants also participated in focus groups. The entire data collected in the study consisted of card sort distribution sheets, demographic/background information from an initial questionnaire, and transcripts from the focus groups. Data were analyzed using Q methodology (Watts & Stenner, 2012) as well as Yin's (2011) five phase approach.

From the analysis of the data, I produced factor interpretations for each factor in the focus group as well as in the full group. Though these interpretations are part of the key findings of this study, they were presented in each factors' section in chapters four and five because they serve to enhance the understanding of the factor arrays. As Watts and Stenner (2012) noted, the interpretation provides "a clear understanding of the overall viewpoint that explains or makes sense of the configuration" (p. 40). This clarity is necessary within the results chapters, particularly for readers who may be unfamiliar with Q methodology. Therefore, I will begin this chapter by presenting the key findings from the study; this includes recapping the various factor interpretations, followed by additional noteworthy findings including an analysis of the findings within the context of constructivism. I conclude the chapter by discussing implications for practice, policy, and research.

Key Findings

There were eight key findings based on the factor interpretations—two from the focus groups and six from the full group of participants. Brief descriptions of the key findings are bullet-pointed and introduced by their thematic heading, as they were presented in chapters four and five.

Factor interpretations.

- *Fiction Builds Bridges* (focus group, factor 1, 47% variance)— There was a strong recognition that fictional literature helps students connect to science content, making it more approachable to students. Potential drawbacks to using fictional literature in science largely were dismissed. There was limited recognition of shared skills and practices between the science and language arts disciplines, as well as a limited perspective on factors that make fictional literature a useful tool for science instruction.
- *Learning from Lack of Use* (focus group, factor 2, 20% variance)—The indication was that backgrounds and experiences with the use of fictional literature during one's own science instruction growing up may have played a role in the perspectives represented in this factor. Fictional literature should be used more than non-fictional literature because it helps stimulate students' imagination, and

the lack of facts does not negate its usefulness. It is important for teachers to know how to select fictional books carefully, so more instruction in how to incorporate fictional literature into science teaching and learning would be beneficial.

- *It Works, Now Tell Me More* (full group, factor 1, 17% variance)—Fictional literature builds excitement in students, and makes science more approachable. It also encourages students to think critically, aids in comprehension, and increases achievement. These reasons point to fictional literature having a significant place in elementary science instruction. Despite its benefits, fictional literature is underutilized in instruction, and there is a desire to know more about how to use it effectively.
- *Been There, Done That* (full group, factor 2, 14% variance)—Fictional literature is a useful teaching tool in elementary science instruction, and is already being used during science instruction. Factors such as helping students access prior knowledge, building interest and engagement with science, encouraging students to make predictions, and providing a foundation on which to develop students' understanding of science contribute to its usefulness.
- *A Walking Contradiction* (full group, factor 3, 10% variance)—There was both agreement and disagreement with the idea that fictional literature should be used during science instruction. Though contradictory, additional analysis of the statements' rankings indicated there is a place for the use of fictional literature in elementary science instruction because stories help get students excited about science and help students connect to the content. There is some desire to know

more about how to incorporate fictional literature into science teaching due to a limited understanding of how to make the connection.

- *No Thanks* (full group, factor 4, 9% variance)—There were more concerns about the use of fictional literature in science expressed in this factor than in any other. One concern was that it will create misconceptions about science, which might prevent students from getting a clear understanding of the content. Even though fictional literature makes science more relatable, the time for using it is not during science, and non-fiction should be used more. To use fictional literature effectively, teachers need to know how to select those books carefully.
- *Learn from the Past* (full group, factor 5, 8% variance)—There was a collective limited background in using fictional literature to teach science, influenced in part by the lack of use during past elementary school lessons in science. There was a strong desire to know more about how to blend fictional literature with science teaching and learning so that students do not develop misconceptions. Fictional literature is an important part of elementary science instruction that is currently underutilized.
- *Academics Trump Imagination* (full group, factor 6, 7% variance)—Fictional literature has a strong place in elementary science instruction, though teachers have to know how to select the books carefully because it is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction. Both students' science knowledge and reading achievement will be positively impacted through the use of fictional literature, and it affords students the opportunity to use critical thinking skills and understand science concepts.

Though it will impact academic growth in students, it will neither get students excited about science nor stimulate their imaginations.

Other noteworthy findings. There is some indication, particularly in factor 2 of the focus group and factors 5, 3, and 2 of the full group, that there is a need for more training and information about how to select fictional books that would aid in science instruction. Though there were some neutral feelings about this in other factors, there were no factors where there was any disagreement. Two of the focus group participants specifically stated that they would like more practice and training in how to blend the two, and a third wondered if there was a good resource she could use to find fiction books that are helpful in teaching science.

This need for more training and resources is due in part to a majority of the participants' having a limited background in the use of fictional literature during science. Analyzing this from a constructivist perspective contributes to a deeper understanding of how TCs constructed their own learning and how their existing understandings may have influenced new learning (Brophy, 2002). Almost half of the participants (44.7%) indicated that their teachers largely used direct instruction, textbooks, and/or worksheets during their elementary science experiences; these TCs have very few models of using fictional literature during science in their own backgrounds on which to draw, making the instruction they receive during methods courses all the more important and valuable. According to Applefield et al.'s (2001) and Tsai's (2002) views of constructivism, new learning depends, at least in part, on preexisting understandings. The lack of innovative models of instruction during elementary science means that some of these understandings developed in different arenas.

As the TCs reported, many of them did not receive much science instruction during elementary school that involved the use of fictional literature. Even though this is the case, that does not mean that their current perspectives were not influenced by their past experiences. Reflecting on their backgrounds enabled TCs to learn from and develop perspectives from positive examples of the use of fictional literature as well as the lack of examples. This act of reflection "is a fundamental process through which human beings gain knowledge from their experiences" (Guthrie & McCracken, 2014, p. 239) situating it as a part of a constructivist approach. The comments of some of the focus group participants shed some light on this.

Tonya, who did not recall teachers using fictional literature during science and who has negative views on science, reflected on her own experience and stated, "if I had been introduced to [science] in a different way, then I think I probably would [like it] because I could relate to it." Juniper's experience in science did not start out positively, but she remembered a distinct point at which a teacher infused excitement into her science instruction and allowed the work to be student led. She recalled, "We were exploring everything, and that was such a new—I don't know, transition point in my life that it was like, 'Oh my gosh! Now I love science and I want to do science all the time." This experience was so impactful that Juniper incorporated this excitement, in part by blending fictional literature with science, into her own practice. She had a job doing after school care, and a part of her work was teaching direct instruction lessons for an hour with premade lesson plans. At one point, she went to her supervisor and stated, "I can't do this. I need to add things to this. This is so boring and you want this to last like an hour." Her supervisor replied that she was not supposed to add anything to the lesson, and Juniper responded by stating,

> Well, I have to. I'm adding a story, and we're gonna do an activity. I remember that day—I read the book, and it was third grade. We did the life cycle. I had them create a butterfly life cycle out of pasta, and they remembered that stuff for so long compared to the other classes.

Erin's current views on using fictional literature during science were shaped by her background as well. She believes that fictional literature helps get students excited about science, and credited former teachers who used this strategy. "In my science career, not career, I guess, but my science journey in school, I had teachers use things like Magic School Bus… and I loved it." She further explained her perspective by stating, "If I can have a book that makes me think of something or if my teacher is reading me a book, and it makes me think of something that happened in my life, then I'm just gonna remember it more." Through reflecting on their own experiences, these TCs developed mental models and understandings of how fictional literature helps shape students' understanding of and appreciation for science.

In the other factors, however, TCs' backgrounds, assessed through statement 3 (I have a limited background in using fictional literature to teach science) and statement 5 (Teachers used fictional literature in my science classes when I was in elementary school) did not appear to be a significant factor in their perceptions about the use of fictional literature in science. This may be due, in part, to the fact that almost one third (28.9%) of the participants stated they had very little recollection about their elementary science experiences.

If you really wanna implement fictional literature, how do you do that? -Juniper

In looking at both factor 1s, which explain the greatest portions of the study's variance, the data showed that the TCs already had some understanding about how fictional literature could be used to support elementary science instruction. However, in those factors as well as several others, there was an indication that more information about integrating the two would be beneficial. What, then, might TCs want to know more about? In both factors, other than encouraging students to think critically, there was limited recognition of the shared skills, strategies, and processes common to both language arts and science. In fact, it is only in factor 6, which incidentally explains the least variance in the study, where the cognitive benefits were recognized as having more importance than the emotive benefits. Cervetti et al. (2006) emphasized the importance of "encouraging students to engage in meaning making around their firsthand experiences [in science] and their reading [and] to be both active and strategic as they do so" (p. 233). In both science and literacy activity, students should activate prior knowledge, establish goals, make predictions, develop inferences, and recognize relationships (Cervetti et al., 2006). This holds equally true for fictional literature as well as non-fictional literature. These strategies serve as a rationale for blending science and literacy together, and are an important part of the discussion surrounding this topic. However, as Sharon noted when participating in the focus group:

> Honestly, this is probably one of the first times anyone's ever really opened up the discussion as to what fictional literature could do for science. Of course, books have always been brought into all of our lessons and through it, but it's

never really been actually a question or talked about, at least in my experience throughout school.

Tonya agreed, stating, "Mm-hmm. This is the first time to me." This lack of discussion helps explain why TCs recognize some benefits of using fictional literature without knowing the research basis behind it.

Having this background knowledge is important as TCs move into their teaching careers. Tonya believed that using fictional literature to help teach science might be an issue for some parents, where they might ask, "'Are you all just reading?'" Being able to explain how fictional literature supports science instruction, both cognitively and emotively, is necessary for teachers, especially if confronted with naysayers. Even if people are not questioning the validity of using fictional literature, having this information to share with parents is important. According to Sharon, "I think that it just—that could be [good] for parents too. Sending home little newsletters with good books that the parents can get for their students would be good. They can get an interest at the home." For the TCs, more instruction is needed in the rationale and research basis for blending the disciplines; this would give them an opportunity to incorporate it into their own practice, share the information with others, and defend their choices if questioned about using fictional literature.

Overall, there was strong support for the use of fictional literature in elementary science instruction by the TCs. For most of the TCs, the perception of fictional literature was that it will encourage students to become more engaged with and interested in science because fictional stories often help build excitement about the topic. These factors all contributed to fictional literature making science more approachable. Spenrico noted that sometimes elementary students feel like, "'oooh, science, it's scary,' [and] they won't even really often take the time to even see if they can engage with it if it's not approachable." Elementary students need to be able to relate to the science concepts, and fictional literature aids in the process. Additionally, the TCs' perceptions were that using fictional literature during science may aid in increasing achievement in both science and ELA, and students who may happen to dislike ELA will not become disinterested in science if the two subjects are combined. All seven focus group participants stated that they would use fictional literature during science once they became practicing teachers, and, for the most part, the full group of participants indicated that fictional literature has a place in elementary science instruction. Concerns about the use of fictional literature, such as the potential to create misconceptions in students, largely were dismissed.

Factor 4 was the outlier. The concerns overlooked in the other factors carried much more weight in this perspective, which accounted for nine percent of the variance in the study. Three participants significantly loaded on this factor, though none of them were in the focus groups. The perception represented by this factor was that it is more difficult to find fictional literature to support the science TEKS than it is to find non-fiction, and that using it neither provides a foundation on which teachers can build students' science knowledge nor aids students in getting a better understanding of the science content. Using fictional literature during science does not help students acquire scientific habits of mind. Fictional literature has a place in elementary instruction, but it is more appropriate in other disciplines.

Implications for Practice, Policy, and Research

Practice. The process of reflecting on one's own experiences contributes to current understandings and perceptions (Guthrie & McCracken, 2014). However, for this to occur, TCs need time and space in which to engage in meaningful reflection. As Sharon indicated, the topic of using fictional literature during science instruction is not one that often comes up. It is critical for methods instructors to have conversations about using fictional literature as a teaching tool in science during courses geared towards preparing future elementary science teachers, and afford TCs the opportunity to reflect on the instruction they themselves received during elementary school, especially considering the lack of quality models of its use during TCs' own schooling. In describing characteristics of effective programs preparing teachers of science, the National Science Teachers Association's (NSTA) position statement on science teacher preparation (2004) stated that programs should "create a learning environment that encourages inquiry, which includes the questioning and evaluating of evidence, justifying assertions scientifically, and reflecting on the prospective teachers' assumptions and practices" (p. 2). Providing time for TCs to reflect on and discuss their own science schooling background with each other may help challenge some of those assumptions that were shaped by having models of science instruction that were textbook and worksheet driven.

In addition to reflection and discussion, innovative instruction about teaching strategies during university level methods courses may positively alter pre-established notions about teaching elementary school science (Kazempour, 2014; Skamp & Mueller, 2001; Ucar, 2012). As demonstrated in this study and in research (Bryan, 2003; Dickson & Kadbey, 2014; Kazempour, 2014), many TCs had a teacher-driven, textbook and worksheet approach to elementary science instruction. From the factor interpretations, the indication is that many TCs would like to know more about how fictional literature and science blend well together, and need more information about the cognitive benefits of blending the two. Therefore, methods instructors should provide careful instruction and experiences in alternative, more engaging methods of science instruction, including the use of fictional literature. This is supported by the NSTA (2004) recommendation that prospective teachers should be provided with a curriculum that supports, among other things, how to find and use "alternative curriculum resources" (p. 2), of which fictional literature is a component.

There are implications for school districts and practicing teachers as well. Because of the positive role fictional literature plays in elementary science instruction, professional development should be offered to practicing teachers that demonstrates its effectiveness and provides models of ways to incorporate it into science lessons. Additionally, schools and districts should provide new teachers with supports for science instruction, through mentoring programs and/or the involvement of a district science coach.

Policy. The NSTA (2004) recommended that science teacher preparation programs have "A structure for collaboration among education, science, engineering, and mathematics departments on the science teacher education course of study" (p. 2) to help "promote the development of needed skills, knowledge, and attitudes" (p. 2) in future science teachers. Although commendable that they are promoting an interdisciplinary approach to science teacher education, there are other disciplines that are not included in the recommendation that have contributions to the field of science along with engineering and mathematics. It is not surprising, however, that these disciplines were accentuated, given the trend towards emphasizing science and engineering practices (Roberts & Bybee, 2014) in national publications regarding science education such as *The Framework* (2012). Although engineering and mathematics practices are integral in science, the potential contributions of effectively using fictional literature as a part of science instruction (Bradbury, 2014; Century et al., 2002; Cervetti et al., 2006; Contant et al., 2014; Dickinson, 1996; Dickinson & Young, 1998; Fleener & Bucher, 2003; Girod & Twyman, 2009; Hapgood & Palincsar; 2007; High & Rye, 2012; Luna & Rye, 2015; Nixon & Akerson, 2002; Osborne, 2002; Ostlund, 1998) deserve more focus in national publications.

In higher education, there should be policies in place that both support the collaboration between science methods instructors and instructors in other disciplines, including ELA, and encourage instructors to move away from a silo approach to their disciplines. Similarly, at the district and school levels, there should be policies in place that support the integration of science with other content areas.

Research. Cervetti et al. (2006) stated that the conversation about the science-literacy connection is "enlightening, interesting, and even provocative—but largely 'data-free,'" and they argued for a shift from "theoretical ruminations about the benefits of integration to tough-minded empirical examinations" (p. 222). Varelas and Pappas (2006) indicated that the research that does exist surrounding the connection between science and literacy tends to focus on non-fiction text rather than fiction. Though this study contributes to the body of work about the use of fictional literature during elementary science instruction, more research is still needed in this area.

Recommendations for Future Research

In light of my review of the literature surrounding this topic, as well as this study's findings, limitations, and delimitations, I have several recommendations for future research:

- The first would be a comparative Q methodology study that examines the perceptions TCs have about the use of fictional literature in science prior to receiving any instruction in the topic during a methods course, much like in this study, and then after receiving the instruction. TCs would complete the Q sort both before and after the instruction, and the resulting factor arrays could be analyzed and compared to evaluate whether the instruction about the use of fiction during science instruction impacted the TCs' perceptions.
- My second recommendation is a longitudinal study following the TCs from their methods courses into their teaching practice to evaluate whether their perceptions changed once they became teachers. Their perceptions regarding the integration of fictional literature into elementary instruction could be assessed via Q methodology during their methods course, and then again after teaching for several years through a combination of Q methodology and interviews.
- Thirdly, a study in which the researcher assesses the actual use of fictional literature, if at all, in practicing teachers' classrooms via observation and interviews would contribute to the research surrounding the use of fiction during science. As a follow-up, in those teachers' classrooms who are using fictional literature during science, students could be interviewed or surveyed to determine

whether there was any impact on their engagement with or understanding of the science content.

- Although this study contributed to the body of work surrounding the impact TCs' background schooling experiences have on their schemas about teaching, it was not the primary focus. According to Russel and Martin (2014), there is much to discover about how individuals learn from their experiences. Therefore, a fourth recommendation for future research would be a qualitative study in which either TCs or practicing teachers are interviewed at length about their experiences during elementary school science and how these practices may have shaped their views.

Conclusion

The idea for this study began with an assignment I give in my undergraduate science methods course, in which students are asked to select books they think will help them teach science. After noticing that more of the books that students were choosing were non-fiction than fiction, I became curious about students' perceptions regarding the use of fiction as a science teaching tool, since I found it to be effective in my own practice. In addition to my own experiences with using fictional literature during science, current research demonstrates the value of blending the two subject areas to increase student engagement, stimulate imagination, build curiosity, make connections, and increase achievement, among other factors (Bradbury, 2014; Century et al., 2002; Cervetti et al., 2006; Contant et al., 2014; Fleener & Bucher, 2003; Girod & Twyman, 2009; Hapgood & Palincsar; 2007; High & Rye, 2012; Kaser, 2001; Luna & Rye, 2015; Nixon & Akerson, 2002; NRC, 2012; Osborne, 2002; Raymo, 1992). Yet, these benefits are not acknowledged in national publications regarding science instruction (NGSS Lead States, 2013; NRC, 2012). Nonetheless, the TCs demonstrated awareness of some of these benefits, although they tended to recognize the importance of the emotive benefits over the cognitive benefits. For some of them, their own backgrounds in elementary science played a role in shaping their current perspectives. There is an indication that TCs would like to know more about how fictional literature can be used as a tool to aid in science instruction, making this an important part of the curriculum in methods courses. According to Bryan (2003), an understanding of TCs' beliefs aids in the development and growth of their professional knowledge during science teacher preparation programs. This study contributes to that understanding, and "cautious generalizations" (Bryan, 2003, p. 862) about TCs beliefs may aid science methods instructors in providing more effective teaching for the perspective science teachers in their courses.

APPENDIX SECTION

Appendix A: Consent Form

TEXAS STATE

INFORMED CONSENT

Study Title: Teacher Candidates' Perceptions Regarding the Integrations of Fictional Literature into Elementary Science Instruction
Principal Investigator: Daphne Everman **Co-Investigator/Faculty Advisor:** Dr. Melissa Martinez

This consent form will give you the information you will need to understand why this research study is being done and why you are being invited to participate. It will also describe what you will need to do to participate as well as any known risks, inconveniences or discomforts that you may have while participating. I encourage you to ask questions at any time. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

- **PURPOSE AND BACKGROUND**

You are being asked to take part in a research project that seeks to examine your opinions about incorporating fictional literature into elementary science instruction. You are being asked to take part in this study because you are enrolled in an elementary science methods course and are working towards becoming a teacher. If you volunteer to take part in this research, your responses to the brief survey and a card sort (using the Q Methodology technique) will be used. You may also be invited to take part in a focus group. The focus group will take place at Texas State University in your regular classroom. The focus group will be audio-recorded with your permission. Taking part in this study is voluntary so you may withdraw from the study at any time without penalty. This would not affect your standing with Texas State University or your grade for this course.

- **PROCEDURES**

If you agree to be in this study, you consent to the following information being used:

- Online survey responses
- Card sort distribution

Additionally, you may be asked to participate in a focus group, and what you share may be included in the study.

I will invite five students per class to meet together in our classroom, ASBN 450B to discuss their views on using fictional literature in elementary science. The discussion topics include: explaining why you sorted the cards the way you did, your own experiences in elementary science, and your thoughts and feelings about using fictional literature to teach science. I will help guide the discussion. To protect the privacy of focus group members, all transcripts will be coded with pseudonyms and I ask that you not discuss what is talked about in the focus group with anyone else. The focus group will last about one hour and I will audiotape the discussion to make sure that it is recorded accurately.

IRB approval application # [illegible]
Version [illegible]

TEXAS STATE

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- **RISKS/DISCOMFORTS**

There is little risk in participating in this study. In talking about your thoughts and opinions, you may become uncomfortable with sharing your ideas. If that happens, you may choose not to answer any of the questions that make you uncomfortable and still take part in the study.

The card sort will include a section requesting demographic information. The combined answers to these questions may make an individual person identifiable, though it is unlikely. I will make every effort to protect participants' confidentiality, and your name will not be attached to any document. However, if you are uncomfortable answering any of these questions, you may leave them blank.

In the unlikely event that some of the survey or interview questions make you uncomfortable or upset, you are always free to decline to answer or to stop your participation at any time. Should you feel discomfort after participating and you are a Texas State University student, you may contact the University Health Services for counseling services at 512-245-2161. They are located at 298 Student Center Drive, San Marcos, TX 78665.

- **BENEFITS/ALTERNATIVES**

There will be no direct benefit to you from participating in this study. However, the information that you provide may help describe and identify ways in which incorporating fictional literature into elementary science instruction has an impact on students.

- **EXTENT OF CONFIDENTIALITY**

Reasonable efforts will be made to keep the personal information in your research record private and confidential. Any identifiable information obtained in connection with this study will remain confidential and will be disclosed only with your permission or as required by law. The members of the research team and the Texas State University Office of Research Compliance (ORC) may access the data. The ORC monitors research studies to protect the rights and welfare of research participants.

Your name will not be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is completed and then destroyed.

- **PAYMENT/COMPENSATION**

You will receive a $10.00 gift card to Einstein's if you are invited and participate in the focus group.

- **PARTICIPATION IS VOLUNTARY**

You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time without consequences of any kind or loss of benefits to which you are otherwise entitled.

- **QUESTIONS**

If you have any questions or concerns about your participation in this study, you may contact the Principal Investigator, Daphne Everman, at dj1102@txstate.edu.

This project 2016A9177 was approved by the Texas State IRB on 7/12/16. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB Chair, Dr. Jon Lasser 512-245-3413 – (lasser@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2334 - (meg201@txstate.edu).

DOCUMENTATION OF CONSENT

I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible risks have been explained to my satisfaction. I understand I can withdraw at any time.

____________________________ ____________________________ ____________

Printed Name of Study Participant | **Signature** of Study Participant | Date

____

Signature of Person Obtaining Consent | Date

Appendix B: Demographic Information

Age:____

Race/Ethnicity:____

Gender:____

Year/Level in School: ________________________________

What grade(s) do you hope to teach after you graduate?__________________________

Do you want to teach all subjects, or just some? ________________________________

If just some, which ones do you hope to teach?_________________________________

Which junior/senior level courses have you completed in the teacher prep program?

Please describe your experiences in elementary science below (type of instruction, time spent on science, feelings about science/enjoyment level, etc.).

____

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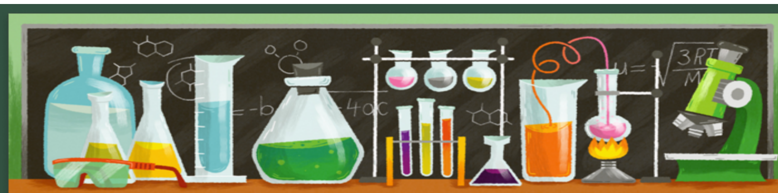
Appendix C: Survey Questions



Survey Questions

* Required

Briefly describe your own elementary science experience (types of instruction, activities, time spent on it, etc.)

What do you know about using fictional literature to teach science? *

Should fictional literature be used in elementary science instruction? Explain your thinking. *

What are some disadvantages of incorporating fictional literature into science instruction? *

What are some advantages of incorporating fictional literature into science instruction? *

What (academic) skills might someone need in both language arts and science? *

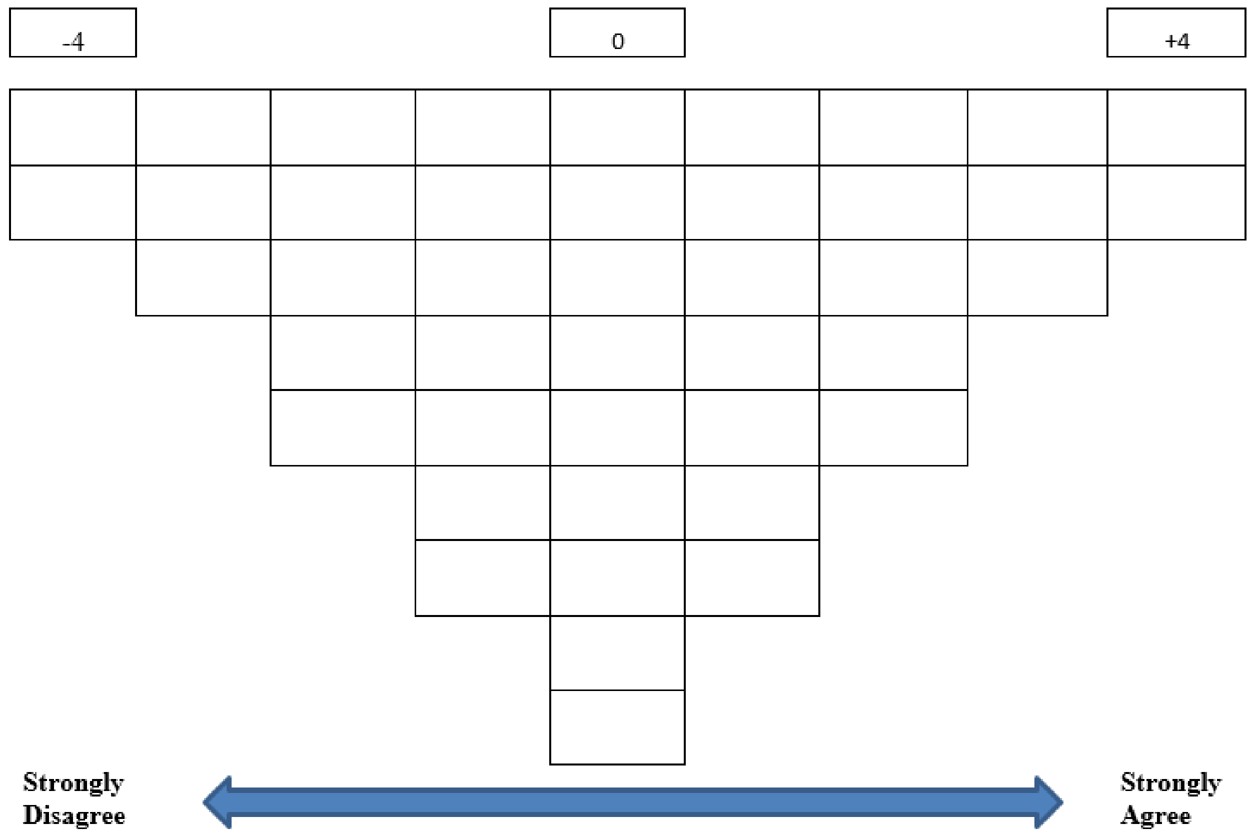
Submit

Never submit passwords through Google Forms.

Appendix D: Q Set Cards

I have a limited background in using fictional literature to teach science. **3**	Fictional literature is beneficial in getting students excited about science. **2**	Fictional literature may lead to misconceptions about science if it adds too much fantasy. **8**	Fictional literature should be used during science instruction. **9**	Fictional literature can be used to make science more approachable to youth. **7**	Teachers used fictional literature in my science classes when I was in elementary school. **5**
I think that using fictional literature to teach science will get the children more engaged and interested in science. **11**	Fictional literature helps make a difficult science concept easier to understand. **13**	Fictional literature uses science vocabulary that is more suited for children than non-fiction. **14**	I would like to know more about how to incorporate fictional literature into science teaching/learning. **19**	Fictional literature helps teach the science TEKS. **17**	Fictional literature should be used to teach science only if it includes actual facts with the story. **16**
Fictional literature should be used to teach science because all subject areas are linked. **21**	Using fictional literature helps children get a better understanding of the science content. **23**	Using fictional literature helps students access their prior knowledge. **25**	Fictional literature will help stimulate students' imagination about science. **22**	Using fictional literature will help students connect to the science content more easily. **26**	Non-fictional literature should be used more than fictional literature in science instruction. **28**
Using fictional literature provides an opportunity for linking personal experiences and feelings with factual information and new concepts. **30**	Reading books is an important part of science instruction. **32**	Fictional literature should not be used during instruction because science is based on factual information. **33**	There is a time for fictional literature in elementary instruction, just not in science. **34**	Using fictional literature encourages students to make predictions, which is an important skill in science. **35**	Using fictional literature broadens the range of science content to which students are exposed. **36**
Using fictional literature will cause students to get caught up in the fantasy part of the story and miss the science content. **45**	Fictional literature will help students acquire scientific habits of mind. **40**	Fictional literature should be used more as a teaching tool in science. **41**	Fictional literature is underutilized in science instruction. **42**	The accuracy of science content suffers in fictional literature. **44**	Students will have a difficult time transferring science information from a fictional setting to a real-world one. **46**
It is more difficult to find fictional literature that connects to the science TEKS than it is to find non-fiction. **15**	Using fictional literature will increase students' science comprehension skills. **53**	Fictional literature will create too many misconceptions to make it a useful teaching tool for science. **27**	Fictional literature has the potential to increase both students' science knowledge and reading achievement. **55**	Fictional literature provides a foundation on which to build and develop students' understanding of science concepts. **39**	Fictional literature stimulates students' imagination and curiosity about science. **56**
Fictional literature and science both encourage students to think critically. **50**	When reading fictional literature, students will confuse imaginary information with the factual science concepts they should be learning. **6**	Using fictional literature during science instruction will help elaborate on the concepts being taught. **12**	Using fictional literature will make science more relatable to students. **29**	There is a lack of understanding about how fictional literature can be used to support science instruction. **37**	Using fictional literature during science instruction will cause students who dislike language arts to become less interested in science. **47**
In order to use fictional literature to teach science, the teacher must know how to select books carefully. **4**					

Appendix E: Distribution Sheet



DISAGREE
Total: _______

NEUTRAL
Total: _______

AGREE
Total: _______

Appendix F: Q Methodology Sort Instructions
Adapted from Van Exel (2005)

These instructions will guide you through the exercise step by step. Please read all of the directions to the end before you start. Then, complete each step one by one before moving to the next one.

1. Take the cards and the score sheet. Lay the score sheet down in front of you. All of the cards contain a statement about fictional literature and science. I will ask you to rank-order these statements from your own point of view. The question is: What role, if any, should fictional literature play in elementary science instruction? The numbers on the cards have been assigned randomly and are only relevant for the recording of your responses.

2. This exercise is about teacher candidates' views and perceptions about the role of fictional literature in science education.

3. Read the statements carefully and split them up into three piles: agree, disagree, or neutral/not relevant from your point of view. Please remember that I am interested in your point of view; therefore, there are no right or wrong answers.

4. When you have finished sorting the cards into the three piles, count the number of cards in each pile and write down how many there are in each pile on the score sheet. Please check to make sure this count adds up to the total number of cards.

5. Next, take the cards from the "agree" pile and read them again. Select the two statements with which you *most agree*, and write the corresponding number in the last two boxes on the right of the score sheet, below the +4 (it doesn't matter which one is on top or bottom). Then, from the remaining cards from the "agree" pile, select the next three statements with which you most agree and write those numbers in the three boxes just to the left of the +4 column. Follow this procedure for all the cards from the "agree" pile. Put the cards to the side.

6. Now take the cards from the "disagree" pile and read them again. Just like before, select the two statements with which you *most disagree* and write the corresponding numbers in the first two boxes on the left of the score sheet, below the -4. Follow this procedure for all the cards from the disagree pile. Put the cards to the side.

7. Finally, take the remaining cards ("neutral") and read them again. Arrange the cards by writing the corresponding number in the remaining open boxes on the score sheet.

Appendix G: Focus Group Questions

The reason we are having this focus group is to explore your thoughts about incorporating literature into elementary science instruction. I need your input and want you to share your honest and open thoughts.

Ground Rules

1. I want you to do the talking!
   a. I would like everyone to participate.
   b. I may call on you if I haven't heard from you in a while.
2. There are no right or wrong answers.
   a. Every person's opinions and experiences are important.
   b. Speak up whether you agree or disagree.
3. What is said in this room stays here.
   a. I want people to feel comfortable sharing when sensitive issues come up.
4. I will be audio recording the group conversation.
   a. I want to capture everything you have to say.
   b. No one will be identified by name in the report. You will remain anonymous.

Questions

- Please explain why you agree most with the statements you placed below the +4.
- Please explain why you also strongly agree with the statements you placed below the +3.
- Please explain why you disagree most with the statements you placed below the -4.
- Please explain why you also strongly disagree with the statements you placed below the -3.
- (after reading the extracted factors) To what degree do you agree with the most commonly held viewpoints in this class?
- Please describe your elementary science experience.
- Do you feel like your experience in elementary science impacted your thoughts about this topic? Explain.
- What type (if any) of readings were included in your elementary science instruction?
- What do you know about incorporating fictional literature into elementary science instruction?
- What are your views on incorporating fictional literature into elementary science instruction?
- What are some positives to bringing it in?
- What are some negatives to bringing it in?

- Once you are a teacher, do you plan on incorporating fictional literature into your science instruction? Why/why not? If you don't, will you use any type of literature? Explain.
- Are there any other comments you'd like to share about this topic?

Appendix H: Full Group Distribution Sheets

-4	-3	-2	-1	0	1	2	3	4
27	38	24	3	21	28	8	18	7
43	34	33	17	32	42	30	20	19
	6	14	15	23	9	4	37	
		5	39	11	41	29		
		40	16	36	1	35		
			31	25	26			
			12	13	22			
				10				
				2				

SubjNo: 1 ID: A

-4	-3	-2	-1	0	1	2	3	4
33	38	28	21	32	41	12	7	11
34	16	43	31	30	9	13	23	14
	27	24	8	25	17	29	26	
		6	1	22	42	10		
		37	15	35	18	39		
			3	5	20			
			19	40	4			
				36				
				2				

SubjNo: 2 ID: B

-4	-3	-2	-1	0	1	2	3	4
15	33	31	5	1	4	22	29	20
43	34	28	21	41	7	14	19	37
	27	25	24	10	35	2	23	
		30	40	11	18	26		
		6	3	17	39	9		
			38	32	36			
			8	13	42			
				16				
				12				

SubjNo: 3 ID: C

-4	-3	-2	-1	0	1	2	3	4
38	43	6	31	5	8	29	41	2
24	33	28	18	1	37	19	22	30
	27	34	36	25	32	11	26	
		9	35	10	23	13		
		15	40	4	39	20		
			21	3	42			
			14	7	16			
				17				
				12				

SubjNo: 4 ID: D

-4	-3	-2	-1	0	1	2	3	4
24	43	2	9	5	20	13	4	22
28	26	27	31	8	36	23	42	25
	33	34	17	1	39	19	3	
		16	21	38	37	18		
		11	7	6	30	40		
			12	15	35			
			29	14	41			
				10				
				32				

SubjNo: 5 ID: E

-4	-3	-2	-1	0	1	2	3	4
14	10	25	41	37	35	17	11	7
15	33	43	19	36	32	26	4	8
	3	40	42	1	20	29	13	
		6	38	18	2	21		
		24	9	23	5	22		
			31	12	34			
			39	27	30			
				16				
				28				

SubjNo: 6 ID: F

-4	-3	-2	-1	0	1	2	3	4
34	33	40	25	23	13	3	9	37
43	24	21	6	39	18	11	4	19
	16	28	12	36	42	26	15	
		27	31	17	32	7		
		38	20	2	30	41		
			29	35	22			
			14	10	1			
				5				
				8				

SubjNo: 7 ID: G

-4	-3	-2	-1	0	1	2	3	4
27	42	34	8	35	4	25	14	12
15	33	37	32	3	7	30	21	11
	28	24	41	22	26	23	5	
		17	10	16	1	20		
		43	38	13	18	2		
			31	40	29			
			6	36	39			
				19				
				9				

SubjNo: 8 ID: H

-4	-3	-2	-1	0	1	2	3	4
38	24	33	15	18	14	7	12	4
34	6	3	19	10	17	13	1	37
	27	8	31	26	20	39	2	
		5	42	36	9	35		
		43	16	11	23	25		
			28	30	40			
			32	21	41			
				29				
				22				

SubjNo: 9 ID: I

-4	-3	-2	-1	0	1	2	3	4
34	43	33	41	31	42	39	19	29
5	16	27	22	24	18	30	13	11
	28	15	9	38	25	3	20	
		40	17	6	26	2		
		14	10	8	4	1		
			21	7	36			
			35	37	23			
				32				
				12				

SubjNo: 10 ID: J

-4	-3	-2	-1	0	1	2	3	4
27	6	24	31	4	36	5	2	19
38	8	15	10	28	39	1	11	7
	43	21	12	3	32	9	23	
		33	26	30	35	20		
		34	25	16	18	13		
			37	42	22			
			40	17	29			
				41				
				14				

SubjNo: 11 ID: K

-4	-3	-2	-1	0	1	2	3	4
27	33	34	17	42	25	9	4	2
43	32	24	8	22	23	3	1	20
	28	38	15	29	30	7	10	
		16	5	39	26	41		
		36	40	37	19	14		
			6	11	21			
			31	18	13			
				12				
				35				

SubjNo: 12 ID: L

-4	-3	-2	-1	0	1	2	3	4
43	4	6	34	17	14	7	29	30
28	16	38	33	13	35	2	41	20
	8	31	27	40	39	36	1	
		22	23	21	32	19		
		15	24	25	12	26		
			9	18	11			
			3	42	10			
				37				
				5				

SubjNo: 13 ID: M

-4	-3	-2	-1	0	1	2	3	4
34	33	6	32	16	25	29	7	30
38	43	24	21	2	22	37	4	19
	27	31	14	13	11	20	35	
		39	40	26	12	3		
		42	41	10	36	8		
			18	9	1			
			28	17	23			
				5				
				15				

SubjNo: 14 ID: N

-4	-3	-2	-1	0	1	2	3	4
33	6	15	42	13	40	1	11	2
34	24	37	14	10	21	18	12	9
	38	27	16	4	22	30	20	
		31	8	26	35	23		
		5	43	39	25	17		
			32	41	36			
			28	29	7			
				19				
				3				

SubjNo: 15 ID: O

-4	-3	-2	-1	0	1	2	3	4
33	38	10	16	17	14	29	11	4
23	43	1	20	24	32	2	28	26
	39	40	5	42	37	21	18	
		41	9	3	36	8		
		15	30	7	34	22		
			13	19	27			
			31	12	6			
				25				
				35				

SubjNo: 16 ID: P

-4	-3	-2	-1	0	1	2	3	4
5	34	8	20	23	9	26	19	7
33	31	24	36	41	12	18	11	2
	27	6	32	42	1	21	37	
		28	40	17	29	25		
		15	38	16	13	35		
			3	39	10			
			43	22	4			
				14				
				30				

SubjNo: 17 ID: Q

-4	-3	-2	-1	0	1	2	3	4
24	6	42	8	12	19	22	11	2
43	14	33	27	4	26	21	25	35
	38	37	1	16	17	10	39	
		3	31	20	41	29		
		34	28	7	9	23		
			15	36	40			
			5	18	13			
				30				
				32				

SubjNo: 18 ID: R

-4	-3	-2	-1	0	1	2	3	4
33	6	5	37	25	39	40	41	9
15	27	8	32	12	1	3	42	2
	43	38	22	31	13	23	7	
		34	21	24	19	10		
		14	29	26	11	18		
			16	4	30			
			28	36	17			
				20				
				35				

SubjNo: 19 ID: S

-4	-3	-2	-1	0	1	2	3	4
43	34	5	17	9	13	7	30	4
38	31	14	8	36	25	22	2	20
	24	33	28	42	11	21	18	
		15	37	41	12	26		
		6	3	35	16	19		
			39	23	32			
			40	1	29			
				27				
				10				

SubjNo: 20 ID: T

-4	-3	-2	-1	0	1	2	3	4
43	16	10	38	17	6	28	25	3
34	14	22	32	5	21	18	36	4
	27	2	31	37	30	7	42	
		23	40	24	13	15		
		26	39	8	19	1		
			20	12	35			
			33	41	9			
				11				
				29				

SubjNo: 21 ID: U

-4	-3	-2	-1	0	1	2	3	4
34	40	15	43	28	23	11	9	4
27	16	24	35	30	37	42	19	7
	38	6	14	36	25	18	2	
		22	3	1	29	12		
		33	8	21	41	39		
			10	13	26			
			32	17	20			
				31				
				5				

SubjNo: 22 ID: V

-4	-3	-2	-1	0	1	2	3	4
36	14	11	30	28	42	39	37	4
43	24	23	41	21	17	20	1	9
	26	22	3	40	13	29	18	
		2	10	32	15	7		
		38	16	35	31	12		
			19	33	25			
			27	34	5			
				8				
				6				

SubjNo: 23 ID: W

-4	-3	-2	-1	0	1	2	3	4
34	6	14	8	23	22	7	37	4
16	38	33	15	10	28	21	32	11
	24	43	9	39	2	35	20	
		27	13	17	1	26		
		31	25	40	41	29		
			18	5	12			
			19	3	30			
				42				
				36				

SubjNo: 24 ID: X

-4	-3	-2	-1	0	1	2	3	4
34	27	43	41	21	23	10	7	2
33	15	16	4	22	26	14	1	42
	38	6	28	39	9	12	13	
		24	40	32	17	11		
		5	8	35	18	19		
			31	20	25			
			3	36	29			
				30				
				37				

SubjNo: 25 ID: Y

-4	-3	-2	-1	0	1	2	3	4
41	15	5	28	42	25	36	3	8
43	14	34	16	13	39	7	19	4
	29	33	27	30	1	11	32	
		37	24	9	2	22		
		21	26	35	12	20		
			23	17	10			
			6	40	31			
				18				
				38				

SubjNo: 26 ID: Z

-4	-3	-2	-1	0	1	2	3	4
5	27	34	9	40	28	8	11	4
43	39	24	14	17	31	22	42	3
	36	38	23	10	20	19	18	
		16	25	1	7	12		
		21	35	32	6	15		
			30	41	2			
			33	26	13			
				29				
				37				

SubjNo: 27 ID: AA

-4	-3	-2	-1	0	1	2	3	4
34	8	6	38	39	28	1	2	11
27	3	24	16	26	13	32	20	22
	15	5	31	19	12	37	7	
		43	33	9	23	17		
		4	21	40	36	18		
			14	41	35			
			29	42	10			
				25				
				30				

SubjNo: 28 ID: BB

-4	-3	-2	-1	0	1	2	3	4
34	6	27	16	2	13	14	7	39
33	38	43	5	28	11	4	20	26
	8	21	9	12	17	29	25	
		15	31	10	22	36		
		42	24	41	18	35		
			32	1	30			
			3	23	40			
				37				
				19				

SubjNo: 29 ID: CC

-4	-3	-2	-1	0	1	2	3	4
43	16	1	23	13	30	35	26	7
34	6	14	41	32	20	5	18	4
	27	33	40	24	22	2	29	
		21	42	12	36	17		
		15	37	19	9	11		
			38	28	8			
			10	3	25			
				31				
				39				

SubjNo: 30 ID: DD

-4	-3	-2	-1	0	1	2	3	4
33	43	5	28	42	37	1	11	20
27	6	32	24	12	8	9	21	4
	38	16	23	13	30	7	41	
		34	10	14	35	18		
		25	17	22	39	2		
			31	26	29			
			15	40	36			
				3				
				19				

SubjNo: 31 ID: EE

-4	-3	-2	-1	0	1	2	3	4
34	31	26	36	41	7	2	18	20
33	16	29	23	11	22	25	39	1
	21	13	40	4	8	42	35	
		43	17	32	19	38		
		24	28	6	12	37		
			27	15	14			
			5	9	30			
				3				
				10				

SubjNo: 32 ID: FF

-4	-3	-2	-1	0	1	2	3	4
34	27	15	31	28	41	32	29	11
33	37	8	40	2	36	12	13	7
	43	1	26	4	30	22	18	
		38	14	16	17	35		
		10	39	42	23	20		
			24	5	9			
			3	21	25			
				6				
				19				

SubjNo: 33 ID: GG

-4	-3	-2	-1	0	1	2	3	4
43	38	24	8	4	18	23	5	1
33	34	6	16	3	37	21	25	35
	31	28	29	2	39	30	11	
		27	15	19	36	32		
		14	13	10	26	9		
			41	20	12			
			42	22	40			
				7				
				17				

SubjNo: 34 ID: HH

-4	-3	-2	-1	0	1	2	3	4
31	34	15	25	36	23	10	30	39
33	27	38	4	13	41	40	18	11
	24	8	3	2	17	32	20	
		6	5	9	29	35		
		43	14	42	26	12		
			28	1	22			
			16	21	7			
				37				
				19				

SubjNo: 35 ID: II

-4	-3	-2	-1	0	1	2	3	4
33	15	28	21	42	39	22	18	11
34	43	6	37	36	32	13	20	7
	31	24	35	30	8	17	4	
		27	26	16	9	12		
		38	14	5	2	23		
			41	40	3			
			1	19	29			
				25				
				10				

SubjNo: 36 ID: JJ

-4	-3	-2	-1	0	1	2	3	4
17	36	9	20	38	3	7	42	25
43	8	37	35	31	30	11	12	14
	6	28	33	40	19	23	4	
		22	2	24	29	21		
		32	26	15	18	1		
			27	16	5			
			34	10	39			
				13				
				41				

SubjNo: 37 ID: KK

-4	-3	-2	-1	0	1	2	3	4
16	34	39	24	36	26	13	22	12
33	28	15	27	10	11	2	18	4
	17	43	3	19	9	25	20	
		41	6	40	37	29		
		5	32	14	23	42		
			35	1	8			
			21	38	7			
				31				
				30				

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