Effects of a Sustained Federally Funded Science Professional Development Program on Elementary Teachers Who Teach Science

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EFFECTS OF A SUSTAINED FEDERALLY FUNDED SCIENCE PROFESSIONAL DEVELOPMENT PROGRAM ON ELEMENTARY TEACHERS WHO TEACH SCIENCE

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ABSTRACT

The purpose of this study was to investigate how participation in a sustained professional development, the Math Science Partnership, improves teacher self-efficacy in science instruction and how it motivates teachers to incorporate elements of the training into their classroom instructional practices. This study considered the perspectives of forty-nine practicing elementary teachers as they participated in a sustained professional development over a two year period. This research study was intended to identify the most successful elements of the sustained professional development and their relationship to teacher self-efficacy in science.

The research design for this study was a case study. While case studies are considered qualitative research, this collective case study utilized a mixed methods research design by including a quantitative component, the Science Teaching Efficacy Belief Instrument or STEBI. Data collection was achieved by a variety of methods and instruments over the course of two years. Data sources included focus groups, observations, questionnaires, and pre-/post-STEBI results.

The study showed that participation in the MSP had a direct impact on daily classroom science instruction. The study results indicated that the MSP professional development program was effective in improving teacher self-efficacy in science, as scores on the STEBI increased at statistically significant rates over the course of the two years. A more detailed analysis of these results found that the STEBI questions with the highest gains were focused on improvements in science content and pedagogical knowledge. Qualitative data from participant questionnaires, focus groups, and observations supported the STEBI findings about improved teacher content and pedagogical knowledge in science. In addition to the themes of improved teacher content and pedagogical knowledge in science, three other themes clearly stood out in the experiences of
each participant. These were (a) increased access to materials and resources, (b) benefits of collaboration with peers, (c) improved self-efficacy in science. These elements, content with pedagogy, access to materials, and inclusion in a community of learners collectively contributed to an increase in participant self-efficacy in science instruction.

These findings inform the educational literature bases as well as professional development providers and science leaders about the types of support and resources that practicing teachers require.
Dedication

The successful completion of my dissertation and doctoral degree are dedicated to my family. There are no words to adequately convey my thanks to my parents, Marsha & Randy and my husband, Jon. Their unwavering support and love helped me move forward each day and successfully complete my dream to receive my Doctorate in Education. My girls also loved and supported me through this degree. Morgan and Carson may not have always understood why I could not go or do, but they loved me anyway. I wanted to complete this degree to show them that with hard work and dedication, anything is possible. My brother, Guy was always proud and encouraging. The strength afforded me by my family support system; saw me through the hard work and long hours.

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Traditionally, classroom teaching in the United States has been viewed as a personal skill, invented and refined by each teacher during his or her career. Good teaching is considered to be the result of each teacher’s doing his or her job behind the classroom door….To achieve small and continuing improvements in the average classroom requires a major shift in educators’ thinking – from teachers to teaching. Rather than focusing only on evaluating the quality of teachers, the educational community must begin examining the quality of teaching. What kinds of methods are teachers using now and how could these methods be improved? Tackling this deep-seated problem begins with opening the classroom door.

- Hiebert, Gallimore, and Stigler (2003, p. 12)

**CHAPTER 1: INTRODUCTION OF THE STUDY**

It was Horace Mann’s goal to make schools available and equal for all, part of the birthright of every American child. The U.S. educational system has scored many extraordinary successes in educating young people. Imagine a world without the telephone invented and patented by Alexander Graham Bell. Reflect on what travel would be like without airplanes invented by Orville and Wilbur Wright. Think about the number of people who would have been ravaged by Polio if it were not for the vaccine invented by Dr. Jonah Salk. Finally, consider how your life would be different if Grace Hopper and others had not developed the computer.

These are but a few contributions from famous American scientists. Scientists have engineered buildings that can withstand earthquakes, investigated alternative forms of energy, created artificial organs and limbs, facilitated instantaneous communication across oceans, and examined the role humans play in changes to the earth. Currently scientists are discovering ways to make cars safer, restore ecosystems and endangered species, locate potentially habitable planets well beyond our solar systems, and use technology to combat terrorism. Science is everywhere in everything we do.
In light of the importance science plays in our lives and society, it is perplexing to observe the minimal attention given to science instruction – especially at the elementary grades (Conderman & Woods, 2008). Dialogue about the quality of science instruction for American students is nothing new. After the launch of Sputnik by Russia, the release of A Nation at Risk (Hartshorne, 2005), and The World is Flat by Friedman (2005), Americans feared that U.S. schools were not producing enough scientists or adequately educating students in science (National Center for Educational Statistics, 2008; National Science Foundation, 2006).

Elementary science education has been a target for reform efforts for over 50 years, with a steady stream of concern over the quality of elementary science, as indicated by declining student achievement in science (Marshall, Horton, Igo, & Switzer, 2009). Despite its importance, science has remained a relatively low priority in elementary schools for many years. U.S. elementary children spend an average of just 100 minutes per week, less than 15 min per day, on science instruction – a number that is dwindling to zero in many schools (Winters-Keegan, 2006; Petrinjak, 2011). Various reasons exist for the minimal attention given to elementary science instruction, including residual pressure to prioritize math and reading instruction due to No Child Left Behind (NCLB). Some elementary teachers report that they receive pressure from their administrators to stop teaching science, because it wasn’t as important as math or language arts in determining the school rating (Creel, 2010; Petrinjak, 2011). This particular trend is changing, at least in the state of Georgia.

In 2013 the Georgia Department of Education adopted a new Career and College Readiness Performance Index (CCRPI). The CCRPI is the accountability system that replaced NCLB Adequate Yearly Progress (AYP) measurement in Georgia (Georgia DOE, 2013). Under the CCRPI system, schools earn points for student achievement scores on all core content areas
equally; language arts, math, science, and social studies. The goal for the new evaluation system was to provide a more comprehensive look at schools and student achievement. The impact is that schools are looking at science with renewed interest.

Most elementary teachers are “teachers” more than they are scientists or “science people” (Hartman & Glasgow, 2002). A significant challenge to providing quality science instruction is the inadequate science backgrounds of many elementary science teachers (Lee & Luykx, 2005). While about 80 percent of elementary teachers feel well qualified to teach reading and language arts, fewer than half feel qualified to teach science (Banilower, et al., 2013; Fulp, 2002). Too often elementary science is taught from a textbook or limited to worksheets or memorization (Conderman & Woods, 2008). These approaches do not convey to students the nature of science or how science knowledge is acquired.

Research studies suggest that subject matter knowledge, professional knowledge, and experience of teachers make an important difference in student learning (Darling-Hammond & Sykes, 2003). In order for elementary teachers to effectively guide students in their exploration of science concepts, teachers must themselves have a good understanding of those concepts. A teacher must feel confident in the subject they are teaching in order to veer off from rote learning that turns so many kids off (Winters-Keegan, 2006). Teacher learning is critical in helping instruction move beyond mechanistic implementation of curriculum (Loucks-Horsley & Matsumoto, 1999). Ultimately, the interactions between teachers and students in individual classrooms are the determining factor in whether students learn science successfully (National Research Council, 2012).

The implementation of the new Next Generation Science Standards (NGSS) is looming on the horizon. Teaching science as envisioned by the NGSS framework requires that teachers
have a strong understanding of the scientific ideas and practices they are expected to teach. However, a National Research Council (NCR) committee charged with reviewing teacher preparation programs concluded that there is virtually “no systematic information on the content or practices of preparation programs or requirements for science teachers across states” (National Research Council, 2012). This means that little is known about what is actually offered in preservice education programs. For this reason and because elementary teachers teach several subjects, it will be especially important to consider how best to meet their needs through ongoing professional development (National Research Council, 2012).

Professional development and teacher preparation should focus on effective methods for teaching science, understanding how students learn science, and helping teachers understand core science concepts and how they connect (Michaels, Shouse, & Schweingruber, 2008; Zepeda, 2008). There is not a professional development formula or recipe that exists to create conditions that will result in lasting conceptual change for all educators. It is unlikely that any single research effort will result in widespread reform of professional development programs, (Guskey, 2002). Teacher education is not an exact science. The focus of the proposed study is on understanding the elements of science teacher professional development, which influence the implementation of instruction in the science classroom. The purpose of this study was to investigate how participation in a sustained professional development, the Math Science Partnership, improves teacher self-efficacy in science instruction and how it motivates teachers to incorporate elements of the training into their classroom instructional practices.

Problem Statement and Research Questions

How do elementary teachers break away from the typical classroom activity structures, which are activity-oriented, devoid of question probing and only loosely related to conceptual
learning goals? Science education faculty at a Kennesaw State University partnered with several neighboring school districts to form Northwest Georgia Science Education Partnership (NGSEP). The NGSEP was awarded a Federal Math Science Partnership Grant. The partnership was designed to provide teachers with intensive learning experiences that build content knowledge, and improve teacher confidence in implementing inquiry-based science in their classrooms. Through the MSP grant, teachers were provided with 180 hours of professional development in science instruction over the course of two years. The NGSEP MSP was subdivided into four cohorts of teachers (3rd grade, 7th grade, HS physics and HS math). Members of the 3rd grade cohort were the focus of this research study.

This study considered the perspectives of forty-nine practicing elementary teachers as they participated in a sustained professional development over a two year period. The researcher used an analytical lens to study the experiences of the teachers longitudinally. Data sources included classroom observations, focus groups, questionnaires, and the Science Teaching Efficacy Belief Instrument (STEBI). Qualitative and quantitative analysis of these data enabled the researcher to interpret the teachers’ experiences throughout their participation in the MSP. Research questions and sub-questions were:

**Research Question**: What are the effects of a sustained federally funded professional development program on elementary teachers who teach science?

**Research Question 1a**: What elements from the professional development motivated teachers to incorporate science instruction into classroom practice?

**Research Question 1b**: What effects did the sustained professional development have on participant self-efficacy as science instructors?
Study Significance

MSP professional developments have been used to improve science and math instruction of teachers across the US for decades. I have been the leader of two previous MSP cohorts. As the leader of the cohorts it was my responsibility to coordinate, plan, and help deliver the professional development received by the teachers. The teachers who participated in these cohorts completed numerous evaluations indicating their overwhelming satisfaction with the training they received during the MSP. Pre- and post-summative assessments, included as a component of the grant evaluation plan, indicated improvements in teacher content knowledge over the course of the grants. While these results were exciting, they did not actually measure what was happening in the classroom. The single most important factor in student success is what happens in the classroom (Darling-Hammond, 2010). I wanted to investigate the impact of the training on the classroom.

The intent of this research is three-fold: (a) to identify elements of the MSP that are being implemented in the classroom; (b) to identify factors that influence their implementation; and (c) discover which elements of the professional learning are being translated into classroom practice. While all who delivered and designed the MSP professional development have classroom teaching experience, most are not currently practicing classroom teachers. It was essential that the unique factors, both successes and challenges, influencing in-service teachers in the implementation of the MSP training were identified and analyzed.

These findings will be utilized to inform the structural framework, design, and content of future MSP professional developments. Grant developers will incorporate the research, data analysis, and findings of the proposed study, into future professional development opportunities provided by the school district, university, and state department of education. Additionally, the
findings from the study will add to the body of research on elementary science instruction and provide a useful starting point for future research.

Limitations of Study

The findings of this study will have limited generalizability. The structure of the professional development and specific nature of the content delivered to the teachers further limits the transferability of the findings. Increased sample size, expanded time period, deeper exploration of the belief systems, and more complex identification and delineation of instructional characteristics would allow for finer grained and more focused longitudinal analyses. These data could also be examined in subsets to provide greater insights concerning the role of the school setting (administrator practices, school culture, student demographics, etc.) on the transfer of professional development into classroom practice.

Definition of Terms

In the course of this study the reader will encounter the following frequently used terms. To better understand this study the terms have been defined below.

Professional Development. Professional development is commonly defined as the advancement of skills or expertise to succeed in a particular profession, especially through continued education.

Self-Efficacy. Self-efficacy is commonly defined as one’s belief in their ability to do something. In the context of this study, self-efficacy in science, or one’s personal belief in their ability to teach science, will be explored.

Science Pedagogy. Science pedagogy refers to methods of teaching and the learning activities teachers use to help students master the content and learning objectives.
CHAPTER II: REVIEW OF LITERATURE

Introduction

This review of literature is divided into two distinct sections. The first section introduces and lays the constructivist theoretical framework for the study; from its roots to its specific implications in science education. The second section presents findings, conclusions, and challenges regarding science professional development. The second section is arranged in three sections: (a) elements of effective science professional development; (b) impact of science professional development on elementary classroom instruction; and (c) unique challenges facing elementary science educators. Both sections will contain elements to help the reader understand the relationship between participation in the two-year MSP professional development and research. Research featured in this chapter will examine designs, implementation strategies, impact on classroom instruction and unique challenges faced during science professional development of elementary educators. Related research on improving teacher self-efficacy in science and motivation to incorporating effective science instruction into classroom practice is shared. The purpose of this literature review is to provide the reader with the basis necessary to address the research questions examined in this study.

Theoretical Framework: Constructivism

By the time an educator steps into a classroom for the first time he or she has had over 16 years of practice at playing the “game of school,” (National Research Council, 2005). The understandings, ideas, and beliefs of these teachers are based largely on their personal experiences (Martin, 2005). Many teachers hold deep-seated conceptions of knowledge as facts, teaching as telling, and learning as memorizing. Failing to overcome these conceptions may result in poor fidelity of implementation of the newly learned knowledge. Teachers may choose
to sample techniques, activities, and materials that fit their current style of teaching, and not engage students in experiences that produce meaningful or lasting change (Loucks-Horsley & Matsumoto, 1999). An educator’s teaching style is shaped and developed over the course of their career.

Constructivism forms the theoretical framework which guides this study. The results of the research are viewed through the lens of the constructivist paradigm, in an attempt to discover what understandings and knowledge elementary educators take from a sustained professional development. Applying constructivist learning theory to classroom instruction necessitates that students are active participants in the learning process. They are more than passive vessels waiting to be filled with knowledge from the teacher. A constant struggle for science educators is to combat resistant misconceptions or alternate conceptions formed by learners. Constructivism by definition states that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When an individual encounters something new, he or she must reconcile their new experience, with prior conceptions or experiences, and decide to replace existing beliefs or ignore the new information as irrelevant (Sewell, 2002).

A common misconception regarding constructivism is that constructivism compels students to “reinvent the wheel.” Instructors should never tell students anything directly but, instead, should always allow them to construct knowledge for themselves. This is actually confusing a theory of pedagogy (teaching) with a theory of knowing (Crawford, 1996). Constructivism assumes that all knowledge is constructed from the learner’s previous knowledge, regardless of how one is taught. Thus, even listening to a lecture involves active attempts to construct new knowledge. Students must experience everything for themselves first
hand, in order to learn. When in fact constructivism at its best taps into and triggers the student’s innate curiosity about the world and how things work. Learners are not required to reinvent the wheel but, rather attempt to understand how it turns, and functions.

Current views on constructivism were initially influenced by the works of Piaget and Dewey and later by Vygotsky, Bruner and Lave. Perhaps one of the strongest voices in the birth of constructivism was John Dewey. Dewey believed that learning should be an active process. It should be organic and develop over time based on the needs and direction of the learner. “It is he [the learner] and not the subject-matter which determines both quality and quantity of learning.” (Dewey, 1902, p. 87). Learners learn by doing. Knowledge or understanding that one does not construct for oneself, out of an intrinsic need to know is ultimately of little use, because it cannot be applied to new and unique circumstances. This is a foundational component of modern constructivism.

Piaget was a biologist who originally studied mollusks and gradually shifted to study children’s understanding of the world around them. His theory asserted that children progressed through a series of stages of development based on their age (Gardner, 2008). Although his stages of cognitive development have been deemed to ridged (Wood, 1989; Gardner, 2008), his research remains prevalent in education. Educators who use the term, developmentally appropriate or age appropriate are generally basing their assumptions on the work of Piaget. While his theories began to decline in popularity in the early 1970s, his impact remains substantial.

Vygotsky and Bruner believed that social interaction played a greater fundamental role in the process of cognitive development. In contrast to Piaget’s understanding of child development (in which development necessarily precedes learning), Vygotsky felt social learning precedes
development. He stated: “Every function in the child’s cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)” (Vygotsky, 1978, p. 57). Vygotsky referred to this social learning aspect as the Zone of Proximal Development (ZPD). ZPD is the distance between a student’s ability to perform a task under adult guidance and/or with peer collaboration and the student’s ability solving the problem independently. Teaches and peers foster intellectual growth by providing instruction within a student’s ZPD (Byrnes, 2008).

Many schools have traditionally operated using a transmissionist or instructionist model in which a teacher or lecturer ‘transmits’ information to students (Driscoll, 1994). This is in stark contrast to Vygotsky’s theory, which promotes learning in context and encourages students to have an active role in the process of learning (Vygotsky, 1978). Jerome Bruner’s work is very much in line with Vygotsky. Bruner also believes that students should be active problem solvers. In his first book The Process of Education (1966), he makes the case for education as a knowledge-getting process:

To instruct someone...is not a matter of getting him to commit results to mind. Rather, it is to teach him to participate in the process that makes possible the establishment of knowledge. We teach a subject not to produce little living libraries on that subject, but rather to get a student to think mathematically for himself, to consider matters as an historian does, to take part in the process of knowledge-getting. Knowing is a process not a product. (p. 72)

In other words, there is more to learning than memorizing information. Enabling students to develop the ability to apply new knowledge is a more desirable goal of education. Dewey also battled against highly structured educational settings which established “a hierarchy of values
among studies,” (Dewey, 1916). He argued that artificial and extrinsically motivated experiences required by formalized educational programs of the time were ultimately of no value.

“Since education is not a means to living, but is identical with the operation of living a life which is fruitful and inherently significant, the only ultimate value which can be set up is just the process of living itself. And this is not an end to which studies and activities are subordinate means; it is the whole of which they are ingredients…The absence of a social environment in connection with which learning is a need and a reward is the chief reason for the isolation of the school; and this isolation renders school knowledge inapplicable to life and so infertile in character.” (Dewey, 1916 p. 369).

While many in education may agree with Dewey’s assertions in theory, putting them into practice has been a challenge. In the era of ever increasing accountability for educational performance what is to be taught has become increasingly scripted. A movement gaining traction in classrooms over the past several years is the idea of contextualizing learning into “real-world” scenarios. This is in contrast with traditional classroom learning activities that involve abstract knowledge situated in meaningless contexts. In contrast, Lave (1991) argues that learning should be situated as it normally occurs embedded within activity, context and culture. More recent studies agree that students learn on their own through the exploration of their environment (Branscombe et al., 2003; Stork & Engle, 1999).

Conceptual change theorists (Posner et al., 1982; Kuhn, 1962; Carey, 2008) believed that knowledge is personally and socially constructed; learners are seen as responsible for their own learning, which can only take place if they themselves ‘construct’ new understandings on
previous experience (Georghiades, 2000). These widespread assumptions regarding the nature of learning have implications for science education. Learners are not viewed as passive recipients, but as partners who are ultimately responsible for their own learning. Learning is seen as involving a change in the learner’s conceptions. Personal knowledge and experiences play a vital role in the acquisition and assimilation of new concepts. The objective is not to eliminate or refute knowledge that was personally or socially constructed. Learners do not incorporate ideas into a meaningful mental framework by having materials simply presented to them. Curriculum should be more than a list of information to be learned. It should be a program of learning tasks, materials and resources which enable students to reconstruct their models of the world (Georghiades, 2000). The goal of teaching is to help learners negotiate the assimilation of new information within their existing schema.

In the classroom, teachers who employ a constructivist approach to learning, apply a number of different teaching practices, (e.g. experiments, simulations, real-world problem solving, etc.) (Martin, 2005). The emphasis is on the active creation of new knowledge and then reflection on how this new knowledge can be assimilated, accommodated, or restructured within the context of existing prior knowledge, (Macceca, 2007). Linking new information to the students’ prior, or background, knowledge activates students’ interest and curiosity and gives instruction a sense of purpose. Learners are able to organize knowledge into cognitive frameworks in what Piaget introduced as schema. In Piaget’s theory a schema is both a category of knowledge as well as the process of acquiring knowledge (Martin, 2005). Every new experience one has is related to and becomes a part of one’s previous experience, which in turn becomes the basis for new understandings and meanings (Dechant, 1991).
Researchers since Piaget have called the incorporation of new knowledge into existing schema by merely attaching it to the existing organizational structures, assimilation. Educational researchers generally use the term *assimilation* to describe the ways individuals fit new information in with old information. Zahorik (1995) explained assimilation as a shaping process in which new experiences are received through existing knowledge structures, while accommodation is reshaping the existing knowledge structure to accept new experiences. Sometimes, it is necessary to alter the schema slightly to accommodate the new information. At other times, it is necessary to restructure the schemata entirely when readers cannot make sense of what they are reading with their existing schemata. *Restructuring* is the term most commonly used for this process (Poplin, 1988).

To make this process clear, consider the following example. When a child first learns about water, she may merely recognize it as what is in the bathtub. She establishes her schema about water. Later she may learn that rain is also a form of water, and she will assimilate the information into her existing schema about water. As she learns more about water, she may learn that water can change state. At this time, the child may not distinguish frozen water from other frozen liquids, and if asked she may confuse ice cream with an ice cube. Therefore, the child must alter her schema about water in its frozen state to accommodate this new information. At some point, the child will learn that water is a composed of hydrogen and oxygen atoms. This may require her to restructure her schema altogether because she may not understand how water can be made of something she cannot see.

**Constructivism in the Science Classroom**

Constructivist methods in a science classroom are generally inquiry based and encourage students to develop questions, formulate and test hypotheses, conduct experiments, make
observations, and draw conclusions (NSTA, 2010). In short students build or construct their own understandings of new ideas based on what they already know. One method for structuring an inquiry-based instructional approach is based on Bybee’s 5E model (Bybee, 1989; Supovitz & Turner, 2007). This model employs the 5Es – Engage, Explore, Explain, Evaluate, and Extend to learning science. Each ‘E’ represents a part of a sequential instructional process or learning cycle designed to help students construct their own learning experiences and ultimate understanding of the topic or concept. The 5E model of instruction was modeled throughout the MSP professional development.

The “Engage” stage, teachers introduce a concept with an intriguing, fascinating, or challenging question or demonstration designed to capture students’ interest, curiosity, and attention. Teachers do not seek a “right answer”; rather they prompt students to talk about what they already know about the topic (or think they know), and discuss what else students would like to know. During the “Explore” stage, students conduct various hands-on or problem solving activities and experiments designed to help them explore the topic and make connections to related concepts, often with groups or teams. During this stage students share common experiences while the teacher acts as a facilitator, providing materials as needed and guiding students’ focus. At the “Explain” stage, teachers help students observe patterns, analyze results, and or draw conclusions based on their activities and investigations. Teachers do not stand and transmit knowledge for student consumption. In the “Elaborate” stage, students build on concepts or ideas they have learned and make connections to other related concepts and new situations. In the final stage, “Evaluation” teachers evaluate, or assess students’ understanding of a topic studied. This evaluation can be formal or informal but should demonstrate a clear understanding of what students have learned throughout the course of the lesson. The 5E
learning model can be employed during a single class period, or extended multiple days as part of a larger unit of instruction.

The multidimensional approach of the 5E method provides educators with a framework to effectively teach science. The National Science Education Standards state: “Understanding science requires that an individual integrate a complex structure of many types of knowledge, including the ideas of science, relationships between ideas, reasons for these relationships, ways to use the ideas to explain and predict other natural phenomena, and ways to apply them to many events (Bransford, et al., 1999, p. 4). It is important that educators recognize that students come to school with prior knowledge and experiences they have used to make sense of the world. One common approach in science education has been to focus on students’ misconceptions (Michaels, Shouse, & Schweingruber, 2008). An extreme version of this view is that a kindergartener arrives to school with a bundle of mistaken ideas that need to be corrected.

A more productive way to look at these misconceptions is to see them as children’s attempts to make sense of the world around them. It is true that science instruction should ultimately aim to have children understand scientific explanations of natural phenomena, but if one jumps to scientific explanations too fast, students will fail to master science in meaningful ways. Often their ideas are part of a larger system of thought that makes sense to them, even though they may be wholly or partially incorrect (Michaels, Shouse, & Schweingruber, 2008). Developing new levels of explanation can be challenging because fundamental conceptual change requires that existing concepts be reorganized and placed within a larger explanatory structure. Learners have to break out of their familiar frame and reorganize a body of knowledge, often in ways that draw on unfamiliar ideas. Because of the complexity of this process, students are likely to require extensive and well-supported opportunities to work on the
development of these new levels of explanation (Bransford, et al., 1999; Michaels, Shouse, & Schweingruber, 2008). In other words, to adequately develop student understanding of science concepts, we have to go beyond a general understanding of effective instructional strategies and have an in-depth knowledge of the content and common research-based misconceptions.

The 5E model, discussed earlier, affords students multiple opportunities to interact with new knowledge and make sense of what they are learning (Bybee, 1998). Conceptual change can be supported when students’ thinking is challenged, as when one group points out a phenomenon that another group’s model cannot explain (Feynman, 1995). To achieve effective learning, a teacher must learn to anticipate student thinking and address problems effectively. This approach requires a great deal of insight and experience on the part of the teacher. Without such insight and experience, it will be difficult for teachers to anticipate the full range of conceptions students bring and the points at which they may stumble (Bransford, et al., 1999).

Similarly, Looking Inside the Classroom (Weiss et al., 2003), a National Science Foundation study, provides additional insights about science teaching. According to the study, the goals of all instruction should be to develop students’ conceptual understanding. As a result, teachers need to provide students with opportunities to learn the content and be clear about the learning goals for each lesson (specific concepts being addressed). The study also showed that lessons judged to be low quality often lacked meaningful opportunities for discussions or student sense making and instead consisted of activities for activities’ sake, with no clear learning target. As a result of these findings, researchers concluded that “teachers need a vision of effective instruction to guide the design and implementation of their lessons.” (p. xiii). Content knowledge alone is not sufficient to prepare teachers to provide high quality instruction. A clear understanding of effective instructional practices (pedagogical knowledge) and pedagogical-
content knowledge are also needed. It is important that classroom teachers are provided the opportunity to engage in high quality professional developments to refine and develop effective instructional practices and content knowledge.

**Science Professional Development**

Teachers everywhere agree: Teaching science, no matter the level, is hard work! To do it well and to be effective requires continuous learning (Darling-Hammond & Sykes, 2003). Not only is the knowledge base that explains science phenomena steadily increasing, research findings that help us understand how students learn are also rising (Tweed, 2009). If you were to ask teachers of elementary science what effective science instruction looks like, the answers would clearly depend upon a variety of factors such as how long they have been teaching, their understanding of science content and pedagogy, their teacher preparation courses, the professional development they receive, and the professional collaboration and conversation they receive that are part of their day to day teaching. This is not a comprehensive list by any means, but it speaks to some of the different influences on teachers’ conceptions of effective science teaching and their levels of preparation to design and provide effective teaching and subsequent learning for their students.

A review of research on effective science teaching illustrated the importance and need for quality professional development. Improved student achievement has long been an indicator of teacher effectiveness. One could argue that student achievement is a result of teacher inputs. If we consider teacher capabilities as part of the inputs, then we need to include teachers’ understanding of science concepts and their understanding of when and how to teach the concepts – their pedagogical content knowledge (Schulman, 1987). To be more effective,
teachers need to participate in professional development that increases content understanding and the ability to decide when and how to present content to students (Tweed, 2009).

What types of professional learning supports the development of a quality teacher? Answers to this question are far from simple. Teacher quality is defined by many variables and effective teaching is the result of a combination of factors, including aspects of the teacher’s background, ways of interacting with others, teacher education, and the implementation of a variety of specific teaching practices (MacFarlane, 2007). Good teaching is normative and made up of at least three components: the logical acts of teaching (defining, demonstrating, modeling, explaining, correcting, etc.); the psychological acts of teaching (caring, motivating, encouraging, rewarding, punishing, planning, evaluating, etc.); and the moral acts of teaching (showing honesty, courage, tolerance, compassion, respect, fairness, etc.) (Fenstermacher & Richardson, 2005).

A teacher’s preparation, relationship with students, and classroom management techniques are inextricably linked with classroom success. When it comes to assessing a teacher’s effectiveness, however, there is nothing more important to consider than the actual act of teaching (Stronge, 2002). There are many elements of the teaching process that have been linked to teaching effectiveness including the strategies teachers use, the clarity of their explanation of the material, and the types of questions they ask. Instructional literature suggests that students whose teachers develop and regularly integrate inquiry-based, hands-on learning activities, critical thinking skills, and assessments into daily lessons consistently out-perform their peers. Stronge (2002) suggested that the qualities of an effective teacher can be summarized as: (1) the effective teacher recognizes complexity, (2) the effective teacher communicates clearly, and (3) the effective teacher serves conscientiously.
The No Child Left Behind Act of 2001, attempted to measure the quality and effectiveness of teachers using student outcomes as a definitive measure of performance. NCLB mandated that a highly qualified teacher be in all the nation’s classrooms by academic year 2005-2006. To accomplish that goal, it was up to each state to define a highly qualified teacher. States were permitted to use teacher licensure tests to demonstrate to the federal government that their teachers are highly qualified, that is, capable, competent, skilled, trained, practiced, and so forth. However, the federal law demanding highly qualified teachers in every classroom, in every state may result in 50 different definitions of quality, with each definition intertwined with, and perhaps inseparable from, the hiring needs of states and districts. The ability to pass a state licensing test did not necessarily equate to high quality practices in the classroom, nor did the inability to pass a state test equate to an ineffective practice.

NCLB required that all teachers of ‘core’ academic subjects be “highly qualified.” (GaPSC, 2010). The Georgia Professional Standards Commission (GaPSC) defines highly qualified at the elementary level through certification. Teachers holding a P-5 Georgia teaching certification are highly qualified to teach any of the core, (reading, language arts, mathematics, broad-field science, broad-field social science) subjects in grades P-5. Certification is earned through completion of degree program and satisfactory performance on the Georgia Teaching Certification Assessment. The requirements of the degree programs vary greatly.

A strong predictor of teaching performance is the amount of coursework in education. Studies by Darling–Hammond (2001) have consistently found positive effects of teachers’ formal education training on supervisory ratings and student learning. Cognition and learning research suggests that students learn better from teachers who go through formal university-based teacher preparation programs (Darling-Hammond, 1999). Despite longstanding criticisms
of teacher education, the weight of substantial evidence indicates that teachers who have had more preparation for teaching are more confident and successful with students than those who have had little or none. An important contribution of teacher education is its development of teachers’ abilities to examine teaching from the perspective of learners who bring diverse experiences and frames of reference to the classroom (Darling-Hammond, 2000). A teacher’s formal pedagogical preparation has been shown to have a positive effect on student achievement, especially in the areas of mathematics, science, and reading. While about 75 percent of elementary teachers feel well qualified to teach reading and language arts, only about 25 percent feel qualified to teach science (Fulp, 2002). Both content knowledge and pedagogical skills are vital aspects of teacher effectiveness (Stronge, 2002).

Teacher beliefs influence practice, attitude, and knowledge. These personal constructs provide an understanding of current practices and can guide instructional decisions, influence classroom management, and serve as a lens of understanding for classroom events (Luft & Roehrig, 2007). When studying beliefs, it is important to clearly articulate the nature of the beliefs that are being examined. Are you looking at beliefs and attitudes, or theories and philosophies with beliefs, or beliefs and knowledge, or beliefs and decision making? This makes a difference in the types of questions you ask and the later interpretation of data. The discrete and multidimensional nature of beliefs can be problematic to those who study beliefs. Individuals can hold beliefs that are in conflict with one another, that have different representations, and that are both generalizable and context specific (Luft & Roehrig, 2007). Beliefs are critical when it comes to understanding a teacher’s practice. Most researchers agree that beliefs are connected to actions in the classroom (Guskey, 1986; Hashweh, 1996; Kang & Wallace, 2004). Some researchers consider beliefs and practices to be interactive, while others
conclude that beliefs must change before practices can change. Self-efficacy plays an important role in the change process.

**Teacher Self-Efficacy**

Teachers who are weak in content background tended to have significantly lower self-efficacy than did teachers with strong content background (Enochs & Riggs, 1990). Studies have indicated that particularly at the elementary school level, low comfort levels towards science and/or science teaching tend to lead to sporadic teaching of science, the teaching of science during inadequate blocks of time, or the omission of science instruction from the school (Connor, 2005).

Self-Efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura, 1986). According to Bandura (1986), efficacy differs from other types of self-appraisal, including self-concept and self-esteem. The most central and pervasive mechanism of personal agency controlling human motivation, affect, and action is self-efficacy. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave. Self-Efficacy is seen as being predictive of a learners’ performance (Bong & Clark, 1999; Bong & Skaalvik, 2003 as cited in Ormrod, 2008). Increasing student performance and achievement in all fields should be the ultimate goal of any educational program. Self-efficacy will not produce achievement on its own. High efficacy will not produce masterful performance when knowledge and skill are lacking (Schunk, 1996). However, learners with low self-efficacy are more likely to avoid situations in which they believe that they will not be successful (Bandura, 1997). Getting learners to participate is difficult without them first believing they have a reasonable chance at success. Therefore, developing a learner’s self-efficacy is a worthwhile endeavor.
According to Bandura (1997), there are four factors that affect self-efficacy. The first is the “mastery experience.” Learners who master a new skill will have an increase in self-efficacy. The mastery experience is the most effective and direct way to improve self-efficacy (Taylor, 2002). The second method of improving self-efficacy is the “vicarious experience.” Seeing someone who is similar succeed raises the observer’s level of aspiration (Taylor, 2002). However, Bandura (1977) points out that the observer must see the social model (the observed individual) as an equal in order for the vicarious experience to be effective at increasing self-efficacy. Still, Bandura and others (e.g., Rosenthal & Zimmerman, 1978) indicate that an offshoot of the vicarious experience, “modeling,” is a major influence in a person’s ability to acquire new skills.

The third method for increasing self-efficacy is verbal persuasion, which is receiving positive verbal feedback from a knowledgeable, outside observer (Taylor, 2002). However, Bandura (1997) again points out that this method of increasing self-efficacy is much less effective than the mastery experience. The previous three factors affecting self-efficacy lie outside the self, either by interaction with others or experiences. The fourth factor affecting self-efficacy relates to the physiological conditions that influence an individual’s self-efficacy (Maurer, 2003). Bandura (1977) referred to these conditions as “affective states.” An example of an affective state would be the fatigue of a student who gets little sleep the night before an exam. The student therefore feels a fogginess of the mind that could lead to lower self-efficacy versus the student who is well rested and prepared who feels confident in their abilities.

Physical states, mood, and emotions are all potential players in affecting one’s self-efficacy in any given situation. Other researchers (i.e. Pajares, 1996; Schunck, 1996) have extended Bandura’s work to additional sources of self-efficacy, such as familial influences, peer
networks, school influences, transitional influences, and gender influences. The study of self-efficacy for learning brings more to the table as each individual assesses their own efficacy beliefs for a given learning task. Self-efficacy, then, can be a major factor in any learning situation (Maurer, 2003).

A positive, significant relationship exists between self-efficacy and academic performance (Moulton, Brown, & Lent, 1991). Learners with high self-efficacy often achieve at higher levels than their peers in a given situation. Bandura (1986) also contends that self-efficacy and achievement are reciprocally linked. Learners who experience success in a new topic develop higher self-efficacy. Self-efficacy and success are inextricably linked in a “chicken and egg” type scenario; it is difficult to separate the origins of the two because they are so closely tied together. The most effective way to increase self-efficacy is the mastery experience (Taylor, 2002). Learners who master new material develop self-efficacy more rapidly than those who do not. However, learners often avoid tasks they believe exceed their capabilities denying themselves the opportunity to experience new growth and, therefore, miss the chance to improve their self-efficacy (Bandura, 1977). Students, who have negative experiences with science early on, tend to develop negative self-efficacy related to their ability to do science. Consequently, they avoid challenging science courses in high school and college.

Improved student achievement was an underlying goal of education. To successfully raise student achievement, the quality of teachers working in our schools must improve. Specifically, we must work to improve the teachers we already have (Wiliam, 2007). When teachers are encouraged to actively take on the role of students in the classroom and provided an opportunity to “get their hands dirty” and experience science like their students, apprehension associated with previously untried concepts is minimized (Taylor, 2002). These practices were
employed to enhance the learner’s sense of control of her science self-efficacy (Bandura, 1994).

Implications for Professional Development

Focusing attention on self-efficacy provides teachers with the tools necessary to maintain productive emotional dynamics and optimism, even when classroom instruction does not go well. Teachers with high levels of perceived self-efficacy, coupled with increased content and pedagogical knowledge, are better equipped to handle the various challenges presented by students in the classroom and more likely to stay the course, thus improving the quality of instruction students receive (Enochs & Riggs, 1989). To provide the necessary foundation the National Research Council (2007) recommends that all K-8 teachers experience sustained science-specific professional development in preparation and while in service. According to the thesaurus of the Educational Resources Information Center (ERIC) database, *professional development* refers to "activities to enhance professional career growth." Such activities may include individual development, continuing education, and in-service education, as well as curriculum writing, peer collaboration, study groups, and peer coaching or mentoring. Fullan (1991) expands the definition to include "the sum total of formal and informal learning experiences throughout one's career from pre-service teacher education to retirement" (p. 326).

By their own accounts, elementary teachers are most in need of professional development, especially related to science, and the least likely to receive it (Fulp, 2002). Professional development is a cornerstone of intervention (Lee & Luykx, 2005); however the quality and availability of professional development can vary greatly. The professional development field is very fond of new theories or labels for professional development that are often produced on limited empirical evidence. There are many professional development one day “shows” that offer important insights about approaches to teaching, but tell little about the
daily classroom practices necessary to achieve similar outcomes. This one-shot approach reduces professional development to “silver bullet” practices that do not adequately prepare teachers for the long arduous task ahead (Harris, 2008).

A review of the literature found that professional development occurs constantly within education but little research is available on long-term or sustained professional development in science and its effects on student achievement (Guskey, 2002). There is good reason to require stronger and more effective science professional development, as more than half of the teachers of science in high poverty and low achieving schools are “inadequately prepared” (Loucks-Horsley, Matsumoto, 1999), or lack a background in their teaching field. Considering teacher subject-area expertise can account for almost half of student academic growth, (in reading and math) (Rhoton, Stiles, 2002), it is vital that high-quality standards and training find its way into America’s schools.

A positive relationship exists between student achievement and how recently an experienced teacher took part in a professional development opportunity such as a conference, workshop, or graduate class (Stronge, 2002). Professional development affects teacher growth, variations in instructional techniques, and improvements in student learning (MacFarlane, 2007). Professional development has been found to be most effective when it is an ongoing process. Well-planned professional development can provide purpose, collaboration, commitment, and community among educators (Langer, 2000).

Though limited, research assessing sustained professional development shows positive results from long-term exposure to sustained professional development. Sustained professional development constitutes professional development that occurs for a minimum of 14 hours (Regional Educational Laboratory at Edvance Research, 2007; Smith & Gillespie, 2007). There
is great variability in scope, depth, and duration of sustained professional developments across the nation. Murphy and Beggs (2005) found that long-term, sustained professional development can have a positive effect on both teacher efficacy and classroom achievement. It isn’t enough for the professional development to be sustained over time. Careful attention to the structure and planning are necessary to ensure that educational stakeholders are not working against each other. Uncoordinated efforts lead to a “patchwork of opportunities,” none of which lead to great success in the classroom or improved student academic achievement (Murphy & Beggs, 2005).

Effective science professional developments are generally grounded in conceptual change learning focused on enabling teachers to engage in constructivist teaching methods (Georghiades, 2000; Louchs-Horsley, Matsumoto, 1999). Many teachers hold deep-seated conceptions of knowledge as facts, teaching as telling, and learning as memorizing. Failing to overcome these conceptions may result in poor fidelity of implementation of the newly learned knowledge. Teachers may choose to sample techniques, activities, and materials that fit their current style of teaching, and not engage in meaningful or lasting change (Louchs-Horsley & Matsumoto, 1999). In order for conceptual change to occur the professional development must be ongoing, 50 hours or more, (Blank, et. al., 2008; Council of Chief State School Officers, 2008) and incorporate content and pedagogy simultaneously (Blank, et. al., 2008; Fishman, Marx, Best, & Tal, 2003; NSTA, 2010). Peer coaching has been effective in helping educators implement newly learned strategies. Through the use of peer coaching or teacher mentoring (Murray, Ma, & Mazur, 2009), teachers are taught how to integrate reflective thought and more student centered instruction into their classrooms (Aschbacher & Alonzo, 2006).

Impact of Science Professional Development on Elementary Classroom Instruction

Research on the impact of science professional development on teachers in the classroom
has yielded very interesting findings. The most frequently reported improvement was in teacher self-efficacy (Bandura, 1989; Fishman, Marx, Best, & Tal, 2003; Louchs-Horsley & Matsumoto, 1999; Luft & Roehrig, 2007). Elementary teachers generally have a limited background in science, and correspondingly a low self-efficacy (Bers & Portsmore, 2005; Louchs-Horsley & Matsumoto, 1999; Luft & Roehrig, 2007). Teachers who participated in sustained professional development models were more likely to make lasting changes to their instructional practices (Supovitz & Turner, 2000). These changes included the use of inquiry based teaching methods such as: notebooks/journals, increased wait time, asking productive questions, pre-assessing, and using the 5E approach to learning (Vasquez, 2008). Instruction in general was found to be more student-centered (Louchs-Horsley & Matsumoto, 1999; Luft & Roehrig, 2007; McDermott, 1993; Supovitz & Turner, 2000). A study conducted by Tate (2001) found that teachers who participated in sustained professional development were able to provide increased opportunity to learn to students. Not surprisingly most students of teachers who participated in sustained science professional developments scored better on standardized assessments than their peers (Rennie Center for Educational Research & Policy, 2008).

Research studies on the effects of science professional development on elementary science instruction are limited. Few researchers are investigating the elementary science classroom. Researchers who have studied the elementary science classroom have chosen to focus on student achievement scores, but do not study what happens in the classroom. The rare exceptions are longitudinal studies conducted by the National Science Board and National Academies of Science. The National Science Teachers Association has declared elementary science instruction a priority (National Congress on Science Education, 2013).

**Challenges Facing Elementary Science Educators**
While the successes mentioned above provide hope for the future, many challenges to successful science professional development remain. The most commonly expresses challenge is a result of NCLB’s focus on math and English language arts. Many district leaders, school administrators, and classroom teachers feel the pressure to ensure that their students meet standards in ELA and math to the detriment of instructional time devoted to science and social studies (Center on Organizing and Restructuring Schools, 1993; Rennie Center for Educational Research & Policy, 2008; Shymansky, Yore, & Anderson, 2004). Compounding this dilemma for school officials is the increase in English language learners and students with special needs who must also meet the requirements set by NCLB (Hart & Lee, 2003). Scientific literacy and understanding are not a major component of the certification requirements and preparation of elementary teachers (Louchs-Horsley & Matsumoto, 1999; Luft & Roehrig, 2007). Unfortunately this lack of emphasis on basic scientific literacy is characteristic of a failure of society as a whole to recognize the value of science (Research Points, 2007).

Summary

Elementary science teachers have not been well supported to do the job they are being asked to do (Michaels, Shouse, & Schweingruber, 2008). Successful implementation of constructivist methodologies in the elementary science classroom requires access to quality professional development opportunities. Teachers need clear examples of effective science instruction. They require sustained support as they work to implement the strategies and techniques in their classrooms with young children. Elementary science teachers need an opportunity to develop their science content knowledge and improve their science self-efficacy. Chapter three will highlight the design components of the MSP, which were carefully crafted to target needs listed above.
CHAPTER 3: METHODOLOGY

Introduction

In education today, there is a well-documented deficiency in science instruction at the elementary level. Federally funded MSP programs have been designed to reduce this deficiency and help improve the quality of science instruction received by students. The purpose of this case study is to look at the effect of sustained professional development in science on classroom instruction and teacher self-efficacy regarding said instruction. The experiences of the teachers participating in the MSP over the course of two years were documented using questionnaires, surveys, classroom observations, and focus groups. These multiple sources of data were collected by an outside evaluator and analyzed by the researcher in order to ensure trustworthiness. Pertinent ethical issues were addressed regarding the study. This chapter detailed the study’s research design, participants, data collection procedures, plan for data analysis, the trustworthiness, and limitations.

Research Design

The research design for this study was a case study. While case studies are considered qualitative research, this case study utilized a mixed methods research design by including a quantitative component. Yin (2009) explained that case study research may include quantitative data. Creswell (2007) stated that the case study research is, for the most part recognized as a type of research that is qualitative in nature. However, as Yin states, “Some case study research goes beyond a type of qualitative research by using a mix of qualitative and quantitative evidence” (p. 19).

Hanson et al., (2005) suggest that including qualitative and quantitative data in a case study provides a depth of research that a single form of research cannot. This mix of qualitative and quantitative data is described as a “concurrent nested design” (Hanson et al. 2005, p.229).
The focus is on either the qualitative or quantitative type of research. In this study, the nested quantitative data were given a less significant role. This case study provided qualitative data with a component of quantitative data in order to offer a deeper level of understanding of the elements of professional learning that were the focus of the study.

The primary approach was a collective case study to explore the impact of participation in the MSP science professional development through experiences of forty-nine elementary school teachers. Creswell (2007) stated that case study research examines a topic by exploring cases in bound systems. This study employs the qualitative case study approach in order to have an in depth investigation into the impact of participation in a sustained professional development on classroom instruction in science. Gall, Gall, and Borg (2007) define the case study “as the in-depth study of one or more instances of a phenomenon in its real-life context reflecting the perspective of the participants involved in the phenomenon.” (p.447).

This case study, investigated how participation in the MSP improved classroom instruction and teacher self-efficacy in science instruction. The qualitative data included questionnaires, observations, and focus groups. In order to explore the impact of participation in the MSP, forty-nine teachers’ experiences were studied as they implement what they learned in their classrooms. These data were collected over the course of two years. The unit of analysis was elementary teachers from 38 North Georgia schools participating in the two-year MSP professional development.

This study also includes a quantitative research component with teacher self-efficacy in science instruction as embedded units of analysis. As stated by Yin (2009) and Creswell (2007), qualitative case study research, can include quantitative data as well. By using quantitative
methods to examine science teaching efficacy, a stronger description of the impact of participation in the MSP emerged.

Yin (2009) depicted a case study as “a linear but interactive” six-step process which includes (a) planning the study, (b) a research design, (c) preparation for the study, (d) data collection, (e) data analysis, and (f) reporting the findings” (p.2). The step-by-step process employed in this study was linear but includes revisiting of the planning and preparing steps. The research design is a plan that gives direction to the researcher in the course of data collection, analysis, and interpretation (Gall et al., 2007). This type of design provides a logical model of proof enabling the researcher to make assumptions about connections among the variables investigated. Yin (2009) posited that the most important goal of the research design is to ensure that the data surfacing during the study answers the research questions.

Creswell (2007) stated, “The data collection in a case study research is typically extensive, drawing on multiple sources of information” (p. 75). This case study includes questionnaires completed at the end of year one and the end of year two by all forty-nine participants, classroom observations, focus group data, and analysis of changes in science teaching beliefs over the course of the two years. The study aims to determine if participation in the professional development has any effect on classroom practice and beliefs about providing science instruction.

Yin (2009) stated, “Defining the research question is probably the most important step to be taken in a research study, so you should be patient and allow sufficient time for this task” (p.10). Research questions need (a) to be appropriate to the study design, (b) require in-depth answers concerning the phenomenon in the study from which to draw rich data, and (c) be driven by the literature concerning the phenomenon in the study (Creswell, 2007).
Research Questions

The research question guiding this study was, “What are the effects of a federally funded professional development program on elementary teachers who teach science?” In an attempt to gain more in-depth insight to this question, two sub-questions were developed: 1) What elements from the professional development motivated teachers to incorporate science instruction into classroom practice and 2) What effects did the sustained professional development have on participant self-efficacy as science instructors.

Research question 1a. What elements from the professional development motivated teachers to incorporate science instruction into classroom practice? These data were collected through classroom observations, focus groups, and participant responses to the questionnaires completed at the culmination of years one and two. The classroom observations were completed by an outside evaluator. The outside evaluator scheduled appointments with all forty-nine MSP participants and conducted classroom observations. Classroom observations were scheduled over an eighteen month period following the completion of the initial sixty hours of the MSP professional development. She used an observation protocol and field notes during the observations. Then she transcribed the field notes and findings into a digital format, removing any identifying information from the file. This digital format was then shared with the researcher. The researcher debriefed with the evaluator to discuss the data to ensure accuracy.

Focus group data were also collected by the outside evaluator on two separate occasions, at the end of the summer institute in year 1 and 2. The focus group sessions were recorded using a digital recorder and transcribed by the evaluator. The transcription was shared with the researcher. Finally, participant responses to the questionnaires were analyzed by the researcher.
Research question 1b. What effects did the sustained professional development have on participant self-efficacy as science instructors? In order to address this question, participants completed the Science Teaching Efficacy Belief Instrument (STEBI) a total of three times. The first time was prior to participating in the MSP. Participants were also asked to complete the STEBI again at the end of year 1 and upon completion of year 2 of the MSP. The STEBI was measured using two scales, personal science teaching efficacy belief and science teaching outcome expectancy. Enochs and Riggs (1990) developed the STEBI to investigate the self-efficacy and beliefs of teachers regarding science instruction (see Appendix I). The STEBI is a 25-item instrument containing items such as, “I am typically able to answer students’ science questions.” Teachers indicate that they either agree or disagree with by choosing from a 5-point likert scale. The pre- and post-STEBI scores were compared using a paired t-test to determine if there was a significant difference in the self-efficacy means. Validity of the STEBI was initially established by Enochs and Riggs (1990) and has been replicated with many other studies over the years (Morrell & Carroll, 2003; Sullivan, 2011).

Participants

The participants for this study were 49 third grade teachers who applied to be part of a two-year Math Science Partnership (MSP) professional development. The MSP was awarded to Kennesaw State University, KSU. As part of this project, KSU partnered with eight different school systems in Northwest Georgia. The participants were selected from these eight school systems based on an application they completed, (Appendix D). Participants were purposefully selected based on five criteria. These criteria were (1) years teaching, (2) employed at a high needs school, (3) limited experience teaching science, (4) the rationale they provided when they applied to participate, and (5) administrator recommendation. Potential participants completed an
application consisting of limited demographic data and narrative responses to three open ended questions. Each application was evaluated by a committee of MSP instructors, including the researcher using a selection rubric, (Appendix E).

Teachers with the fewest years teaching were given the highest rating on selection rubric. Teachers teaching in a high needs school, a Title-I school or school with a high percentage of students not meeting standards on the state science assessment, received the highest rating on the selection rubric. Participant responses indicating limited access/participation in science professional development or self-identified lack of proficiency in science instruction, received the highest rating on the selection rubric. Forty-nine teachers representing forty different schools were ultimately selected to participate. Teaching experience of the selected participants is listed in Table 1. Twenty-three of the schools are Title I schools. Title I schools are schools where a minimum of 75% of the students receive free or reduced lunch. Thirty-nine of the schools were public schools. Two were public charter schools and one was a private school.

Table 1

<table>
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The participants were part of two cohorts that participated in the two years of the MSP professional development. Participation in each cohort was determined by the location of the participant’s school. Participants teaching in school in the northernmost school districts were
part of the north cohort. There were a total of nineteen participants in the north cohort.

Participants teaching in the southernmost districts were in the south cohort. The south cohort was larger, with 30 participants. Participants remained with the same cohort throughout the MSP. On different occasions, such as fieldtrips, the cohorts met jointly. These cohorts remained static over the course of the MSP. Each cohort met independently of one another.

Setting/Site

The MSP professional development took place over the course of two years. This is the prescribed format for federal MSP programs, but is far from the norm for most professional development opportunities. In that time the research was able to build familiarity with the setting and the people (Marshall & Rossman, 2006). The field procedures of the case study protocol included (a) gaining access to organization and participants, (b) having necessary resources, (c) creating a clear schedule for collecting data, and (d) preparation for unplanned occurrences (Yin, 2009). During year one the participants engaged in ten consecutive days of professional development over the summer and four follow up professional development days during the school year. They followed the same schedule during year two. In total they participated in over 160 hours of professional development provided by a team of experienced science leaders, including the researcher. The MSP paid participants a stipend to attend sessions over the summer and provided teachers with funds to pay for substitutes during the school year.

Instructors

Each cohort was taught using identical professional learning activities by the same instructors. The instructors for the MSP included a veteran educator with 40+ years of teaching and administrative experience and the researcher with 19+ years of teaching and administrative experience. Both of the primary instructors were former elementary science teachers and
continue to be involved with elementary science instruction to date. The instructors spent much of the instructional time modeling proper science pedagogy. Participants were encouraged to embody the role of their students. Participants spent time engaged in activities such as hands on experiments, lesson study, journaling, collecting data, building grade level content knowledge in science, and science pedagogy. Through the MSP grant, participants were provided with the materials necessary to replicate each experiment in their classrooms.

**Researcher’s Role**

Case studies must accurately reveal the etic perspective of the writer (Gall et al., 2007). “The role of the case study researcher becomes at times the measuring instrument in data collection and becomes personally involved with the phenomenon being studied” (Gall et al., 2007). I am the science supervisor of elementary curriculum and instruction at the central office of a school district with the greatest number of MSP participants. I also served as the elementary cohort instructional leader during the MSP. I have received trainings and presented trainings on various science educational issues. In my school district, it is my role to improve the quality of science education at the elementary level. This is accomplished through professional learning opportunities, programs, and curriculum development. I share a common goal with the participants in this study: to improve the quality of science instruction provided to our students.

In a qualitative research proposal such as this it is critical that the findings have an element of "conformability," that remains objective despite the researcher immersion in the study (Marshall & Rossman, 2006). Due to my bias and my role as an administrator, an outside evaluator was employed to carry out the data collection. The decision to use an outside evaluator was purposeful, to avoid skewing the data from participants eager to please or praise my role in
the MSP. A pilot study conducted by the researcher prior to beginning this study uncovered a
limitation to the trustworthiness of the data collected, (Creel, 2007). The outside evaluator also
serves as the evaluator on a number of similar grants. The outside evaluator administered and
collected all of the data and removed all participant identifiers, prior to sharing it with me. I
worked closely with the grant evaluator during the data analysis. Additionally a member of my
dissertation committee, fellow MSP instructor, and the other science supervisor in the district
played the role of critical friend (Marshall & Rossman, 2011) – scholars external to the
phenomenon being studied whom I asked to evaluate my inferences and findings. He questioned
and confirmed analyses. These shared processes added to the validity and trustworthiness of my
study.

Data Collection

Gall et al., (2007) recommended the use of multiple methods of data collection about a
central phenomenon in order to improve validity of case study results. The data collected in this
study allowed emic perspective to be shared as the experiences of the teachers were shared over
the two years of the MSP. According to Marshall and Rossman (2006), qualitative researchers
typically relay on four methods for gathering information: (a) participating in the setting, (b)
observing directly, (c) interviewing in depth, (d) analyzing documents and material culture.
Documents can take many forms, such as emails or daily reflections from participants.

Questionnaires

The word questionnaire is typically used in a very general sense to mean any printed set
of questions that participants in a survey are asked to answer, either (a) by checking a choice
from among several possible answers or (b) by writing out an answer, (Thomas, 2003). Most
questionnaire studies involve cross-sectional measurements made at a single point in time or
longitudinal measurements taken at several different times, (Marshall & Rossman, 2006). The questionnaires, Appendix F, used in this study were longitudinal measurements taken at the end of year one and at the end of year two. The questions included on the questionnaires were developed by the MSP coordinator at the Georgia Department of Education. The questionnaires were administered to participants digitally by the outside evaluator.

Reflections on the effectiveness of specific aspects of the MSP professional development were the focus of the questionnaires. The questionnaires consisted of six items participants ranked using a Likert scale and six open-response questions. The first section of the questionnaire with the rating scale was designed to identify participant reflections on activities that may not have been uppermost in participants minds (and thus overlooked in the open-ended-question section) but about which they nevertheless could provide valuable data, (Thomas, 2003). The Likert items were based on a scale of “1- strongly disagree” to “5 – strongly agree.” The second section of the questionnaire asked participants to reflect on components of the MSP professional development they found most beneficial, least beneficial, and offer suggestions to influence future MSP sessions. Participant responses to these open ended questions were analyzed and coded by the researcher. The researcher looked for trends and themes in the data.

The relative advantages and disadvantages of survey research are weighted according to the following criteria: (a) appropriateness of the method to the problem studied, (b) accuracy of measurement, (c) generalizability of the findings, (d) administrative convenience, and (e) avoidance of ethical or political difficulties in the research process, (Marshall & Rossman, 2006). An important strength of the questionnaires is that they enable a researcher to collect a large quantity of data in a relatively short period of time, (Creswell, 2006). This study collected responses to twelve different items from forty-nine participants over a two year period.
A significant disadvantage of using surveys and questionnaires was that, if the researcher was not present to supervise the participants as they complete the questionnaire, participants can easily avoid filling out and returning the form, (Thomas, 2003). In addition surveys and questionnaires given to participants to complete at the end of the day generate superficial responses due to fatigue or competing factors such as the desire to leave. In an attempt to combat both of these issues participants were asked to complete the MSP questionnaires within a one-week window following the MSP. A link to the online questionnaire was emailed directly to each participant. Participants were able to choose a time to complete the survey. The outside evaluator monitored completion of the surveys by participants to ensure that 100% of the questionnaires were completed. This reduces the amount of nonresponse bias on survey results, (Creswell, 2003).

**Observations**

Direct observations of science instruction by MSP participants were conducted. A forty-five minute formal observation occurred in each MSP participant’s classroom. The observation was scheduled at a time convenient to the MSP participant. Observations focused on the relationship between the lesson-plan provided, the instruction observed, and knowledge gained during the MSP. Additionally the degree of student engagement was also recorded. The outside evaluator used a modified version of the observation form taken from the Georgia Department of Education (Appendix G) recommended evaluation forms to ensure consistency and completeness.

The use of the observation protocol enabled observations of the science instruction in action in the classroom with students, instead of an experimental model. The protocol collected data regarding student engagement, application of content from MSP, and use of best practice
strategies. The outside evaluator recorded observations on a hard-copy of the observation protocol. Additional antidotal notes regarding teacher self-efficacy as evidenced through rapport with students, comfort with being observed, evidence of lesson/instruction being typical or atypical, artifacts – such as science notebooks, student work, anchor charts, etc., in the classroom were also included in the comments section of the observation protocol. These notes were transcribed by the outside evaluator into a digital format with the observation data.

Focus Groups

The method of interviewing participants in focus groups comes largely from marketing research but has been widely adapted to include social science and applied research, (Marshall & Rossman, 2006). Four focus groups were conducted during the MSP. Two focus groups were held with participants from the north cohort and two with participants from the south cohort. The outside evaluator conducted the focus group sessions utilizing a semi-structured questioning protocol developed jointly with the researcher (Appendix H). The focus group sessions occurred at the end of the summer institutes during years 1 and 2.

Marshall and Rossman (2006) state that the focus group method assumes that an individual’s attitudes and beliefs do not form in a vacuum: “People often need to listen to others’ opinions and understandings to form their own”, (p. 114). Focus group sessions were conducted face to face and lasted approximately one hour. The evaluator taped the sessions using an audio recorder. Following the completion of the sessions, the recordings were transcribed. Transcriptions of the recordings, not the actual audio files, were shared with the researcher. Creswell (2003) notes that information filtered in this way provides the researcher with an indirect picture of the nature of the focus group. Tone, inflection, and other subtle meanings are not articulated on the transcription. The judgments involved in placing something as simple as a
period or semicolon are complex and shape the meaning of the written word, (Marshall & Rossman, 2006). The researcher engaged in fact checking with the evaluator to ensure that the data analysis accurately reflected the spirit of the focus group sessions.

**STEBI – Science Teaching Efficacy Belief Instrument**

The STEBI is classified as an inventory, or printed document on which participants in a research study are asked to report their attitudes or preferences – their dislikes, and their approvals and disapprovals, (Thomas, 2003). Prior to beginning the MSP each participant was asked to complete the Science Teaching Efficacy Belief Instrument (STEBI). Questions on the STEBI, (Appendix I) were crafted to correlate to teacher self-efficacy or outcome expectancy. Teachers were asked to indicate on a five point Likert scale the degree to which they agreed or disagreed with self-efficacy statements such as: “I find it difficult to explain to students why science experiments work.” As well as outcome expectancy statements such as: “If students are underachieving in science, it is most likely due to ineffective science teaching.” For the purposes of this study, the primary focus was on the questions related to self-efficacy. Participants were given another STEBI at the end of the MSP. Both instruments were administered digitally by the outside evaluator. Participant responses were coded on both instruments to allow for a comparison of data to determine if there was a significant difference self-efficacy means.

**Data Analysis**

Three types of data analysis can be used in case study development, “interpretational, structural, and reflective analyses” (Gall et al. 2007, p.465). The present study employed an interpretational analysis to reveal themes and patterns regarding the impact of the MSP on classroom instruction and teacher self-efficacy. The data were collected by the outside
evaluator. Copies of all raw data were maintained by the outside evaluator. Digital copies of these data were shared with the researcher. The researcher maintained digital copies of these data on a password protected computer. Copies of coded data were also maintained on the same password protected computer. Qualitative data analysis consisted of the narratives from the questionnaires, transcripts of the focus groups, and initial participant applications. These data were reviewed collectively as to provide a comprehensive and holistic picture of phenomena associated with the transfer of professional development into classroom practice.

**Memoing.** Memoing notes were written in the margins of transcripts and narrative survey responses to aid in the beginning stages of examining the data. Notes were transcribed into a T-chart with the facts of the case on one side and my reflections, opinions, and connections on the other side. Memoing blends the research’s reflections and impressions of the moment with information from the data during the data collection and analysis, Marshall & Rossman, 2006). By collecting these notes, the researcher was able to organize thoughts, make connections, and add reflections based on data.

**Coding.** Creswell (2007) stated open coding is an initial step in data analysis. Initial data analysis consisted of immersion in the narrative data collected during each observation and transcribed interviews, followed by filtering the data through the lens of constructivism. The researcher spent time reading, and re-reading all data sources to become intimately familiar with these data (Marshall & Rossman, 2006). Following the immersion the researcher conducted an initial coding of the data according to their relationship(s) to the elements of the theoretical framework of constructivism. Specifically the relationship of how the participants gained new knowledge. These elements framed the initial themes.
This approach was utilized to examine the broader interpretive frameworks participants use to make sense of the professional development experience (Grbich, 2007). These data were text coded to highlight salient points in common with and in addition to those identified during initial analysis of the observation and open response data. These data were further explored to identify their relationship specific professional development events or experiences. A comparison of the content and context of participant data were analyzed in an attempt to link the stories to the most relevant experiences they share in common and those unique to individual participants. The initial patterns which emerged evolved with each subsequent analysis. The very early data families became more developed and precise over the course of the analysis.

Looking at qualitative data, without taking into account its place within a larger system and its relations with everything else, provides a narrow – perhaps even flawed – interpretation (Roth & Lee, 2007). Roth & Lee (2007) use the analogy of threads, strands, and fibers to illustrate the significance of the dialectical orientation of those being studied. It was possible to recognize strands and individual fibers, but these only tell a fraction of the story. In order to view the setting holistically, it was important to look at how the strands and fibers are used to form a thread and in what context that thread was being utilized. These data were analyzed collectively within the context of the MSP cohorts of participants. This served to provide a more comprehensive holistic view of how teachers translate their professional development into the context of their classrooms.

**Direct interpretation.** Direct interpretation was used to allow for a focus on a single concept for a deeper meaning of the phenomenon in the study (Creswell, 2007, p. 163). In some critical aspects of the case, instead of looking across all the data for interpretation horizontally, meaning was determined from a single experience of a teacher in order to dig deeper and gain
understanding. This in depth analysis allowed the researcher an opportunity to gain insight into a single, important experience of the teacher in isolation. For example, if the teacher discusses the challenges faced when teaching science, it will be important to determine what challenges are related to the teacher’s knowledge and skill in effective science instruction and what challenges are related to the school environment. In this manner, issues will surface that cannot be controlled by the teacher.

**Naturalistic generalizations.** Creswell (2007), states that naturalistic generalizations are a final step in the data analysis process. In analyzing the data, generalizations concerning transfer of professional development into classroom practice came to the forefront. An example of this was the issue of time (time in the instructional day to teach science, time to set up a lab, time to allow the students to engage in inquiry methods, time to locate materials needed to conduct a lab, or time to allow students to challenge their misconceptions). The researcher shared these findings with the district’s science supervisor and fellow MSP leader, so that future MSP instruction could be made more efficient and effective for participants. The generalizations that arose from this case study were compared to and contrasted with information found in related literatures.

**Statistical analysis of STEBI data.** In order to determine the impact of the MSP on teacher self-efficacy, pre- and post-STEBI scores were analyzed. First the STEBI questions were disaggregated into two groups, questions related to the self-efficacy and questions related to belief. For this study participant responses to each question relating to self-efficacy of the pre-tests were compared to their responses to the same questions on the post-test. The mean for growth on each question was calculated and compared. The standard deviation (SD) was used to measure the extent to which scores in the distribution deviated from their mean. After the SD
was computed, a test for the statistical significance of observed differences in the mean scores of
the pre- and post-STEBI scores was completed (Gall et al., 2007). A $t$ test was used to determine
the level of statistical significance of an observed difference between sample means for each
question on the self-efficacy scale. The null hypothesis was rejected if the $t$ value reached a
significance level of $p < .05$. This value is intended to help prevent Type I errors while at the
same time reducing the possibilities of Type II errors.

**Research question 1a.** *What elements from the professional development motivated
teachers to incorporate science instruction into classroom practice?* The data for this research
question were analyzed by open coding, memoing the transcripts of focus group interviews,
classroom observations, and questionnaire responses.

**Research question 1b.** *What effects did the sustained professional development have on
participant self-efficacy as science instructors?* The data for this research question were analyzed
by open coding, memoing the transcripts of focus group interviews and questionnaire responses.
A $t$ test was used to analyze STEBI scores.

**Triangulation of data.** Yin (2009) stated, “Any case finding or conclusion is likely to be
more convincing and accurate if it is based on several different sources of information following
a corroboratory mode” (p. 116). The triangulation of multiple sources of data aided construct
validity. These types are (a) questionnaires completed at the end of year one and the end of year
two by all forty-nine participants, (b) classroom observations of all forty-nine participants, (c)
focus group data, and (d) analysis of changes in science teaching beliefs over the course of the
two years. Figure 1. *Triangulation of data,* shows the relationship of the data collected. The
findings obtained from the STEBI provided the foundation on which the other data sources were
analyzed. These data were organized into a matrix of sorts, with the qualitative data sources
along the top supported or challenged by the findings of the quantitative data. As the data were analyzed, central themes of the research identified from each data source. This organization allowed the researcher to identify authentic codes and themes as they emerged. The research team collaborated to complete the data analysis.

Peer review. Peer review or debriefing provides an external check of the research process (Lincoln & Guba, 1985). Lincoln and Guba (1985) define the role of the peer in the debriefing process as a “devil’s advocate” an individual who keeps the researcher honest; asks hard questions about methods, meanings, and interpretations. The researcher’s dissertation committee is made up of three members who have experience with science teacher professional development through the MSP. As data were analyzed, committee members met with the
researcher to discuss emerging themes. Some findings were questioned and suggestions for alternative interpretations were offered.

**Reflexivity/Memoing.** Memoing is writing reflective notes in the margins of the transcripts, (Marshall & Rossman, 2006). These notes were transferred electronically onto a T-chart to separate the facts of the case and the researcher’s thoughts and opinions. This separation was important in recognizing the researcher’s in the study and added in credibility.

**Member checking.** In member checking the researcher solicits participant feedback on the credibility and dependability of the findings and interpretations (Creswell, 2007). This technique is considered by Lincoln & Guba (1985) as the “most critical technique for establishing credibility” (p. 314). According to many qualitative experts, the participants should play an important role in the data analysis process of a case study. Participants in this study were provided with rough drafts of narrative interpretations, not raw data. The researcher sought to receive feedback on the accuracy of the descriptions and identification of any missing elements. The process of member checking provided an opportunity for the researcher to identify external variables.

**Case study database.** Case notes, diagrams, questionnaires, transcriptions, and data were stored on a password protected computer and online storage server. The outside evaluator maintained control of all data containing participant identifiers. Security and confidentiality of all artifacts were ensured. The case study database adds to the confirmability of a study and helps in the potential replication of a study.

**Audit trail.** Data stored carefully with good organization allows the final report information to be traced back to the initial data in its raw form. All information was labeled chronologically and filed, which established a timeline of the case study to aid in replication.
The audit trail provides accountability of the research and transferability of the study (Creswell, 2007). This safeguard reduced the chance of losing important data and undue influence of bias as the facts of the case unfold.

**Trustworthiness**

Maintaining credibility and dependability ensure a high-quality research study (Lincoln and Guba, 1985). Creswell (2007) suggests that the researcher use several accepted “validation strategies” to document the accuracy of the study (p. 207). A variety of approaches were built into this study to meet the needs of the reader in order to aid in understanding and replication so educators will be able to utilize the study as they strive to improve the effectiveness of science teacher professional development: (a) the use of clear, important connections between research questions, data collected, and findings, (b) the study is truthful and straightforward, with the use of direct quotes and detailed descriptions, (c) simple statistics from the data were employed to provide a foundation for conclusions of the study, and (d) thick description was used through the study.

Many strategies aid in building authenticity in qualitative research, including triangulation, member checks, a case study data base, and an audit trail. The reliability and validity of the quantitative components of this study were accurately reported. The instrument used to measure participant self-efficacy; the STEBI was initially established by Enochs and Riggs (1990) and has been replicated with other studies over the years (Morrell & Carroll, 2003).

Another strategy used to help establish trustworthiness was the employment of an outside evaluator to collect and transcribe the data. The outside evaluator also helped to reduce any level of influence or bias on the part of myself as the researcher and science supervisor of the district. The outside evaluator has extensive experience with data collection and the MSP in general. The
data were captured and participant identifiers were removed. Prior to the data collection, the researcher and outside evaluator met and discussed the process and questions. After each focus group session, the outside evaluator and researcher met to debrief. Following the transcription of the data, the outside evaluator and researcher met to discuss the outside evaluator’s thoughts and impressions. Marshall and Rossman (2006) caution transcription is not “merely a technical task.” They go on to say that once the data have been transcribed, they are not raw data any more – they are “processed data,” (p.110). Thick description was used to express the details of the information, and the participants provided member checks of all transcribed information for accuracy and completeness. These combined measures helped in overcoming the crisis of representation and maintaining trustworthiness.

**Ethical Considerations**

“Data collection and case study research poses various ethical problems” (Gail et al., 2007, p. 459). It is vital all research be transparent and strives to protect those involved in the study. This study worked to ensure accurate information was presented and study participants were protected. Study participants names were not included in this study. The researcher used the random participant numbers assigned by the outside evaluator as pseudonyms in order to ensure anonymity and confidentiality. The purpose of this study was for the voices of the teachers to be heard in order to provide a way to maximize limited professional development opportunities. In order to make sure the research was accurate and the teacher’s words were used, several safeguards are in place. There was a constant review of the data by the teachers throughout the case study. Experts such as the researcher’s dissertation committee members and fellow MSP leaders were consulted, and literature on the subject of science professional development were explored.
The Chief Academic Officer and director of research for the school district involved in the study was provided a written explanation of the study, and her permission was gained prior to beginning the case study (Appendix A). Permission was also obtained from the Kennesaw State University Institutional Review Board (IRB) so the study could move forward (Appendix B). The IRB's purpose is to regulate all research activities involving human subjects on the campus of Kennesaw State University, ensuring that people who participate in research are treated ethically and in compliance with all federal and state laws and regulations.

**Limitations**

As with any study, there are limitations in the methodology. The use of an outside evaluator can be viewed as a limitation. The outside evaluator and researcher met on several occasions to discuss the collection process. Although the outside evaluator worked diligently to capture the information during the observations and focus groups; Schwant (2007) and Onwuegbuzie, Leech, and Collins (2008) posited that it is difficult, if even possible, to adequately describe a lived happening. Schwant defined, “Crisis of representation as the uncertainty within the human sciences about adequate means of describing social reality” (p. 48). However, Onwueguzie et al. explain that a planned, careful debriefing between researchers can help to overcome many problems in capturing the lived experience. Most of the data collected for this study were self-reported by participants. The study did not question that other variables might have concurrently influenced the data reported by study participants.

**Summary**

This study was designed to provide the researcher with the data necessary to examine the effects of a sustained professional development on elementary science teachers. This study
utilized a mixed methods research design. Data collection was achieved by a variety of methods and instruments over the course of two years. Data sources included focus groups, observations, questionnaires, and pre-/post-STEBI results. Chapter four will explore the process of data analysis used during this study.
CHAPTER FOUR: RESEARCH RESULTS AND FINDINGS

Introduction

Many professional development opportunities are provided for classroom teachers. These opportunities are often implemented as a singular experience. There are limited professional development opportunities that are sustained and provided to classroom teachers over time. Fewer still target improving the science instruction and content knowledge of practicing classroom teachers. As evidenced in the review of literature, research on effective elements of sustained science professional development is limited at best. This case study examines the transfer of elements of the two-year Math Science Partnership professional development into classroom practice. Moller and Pankake (2006) state, “Professional learning modules are tools to be used, but the real learning happens in the cycle of conversations, actions, evaluation, and new actions that is supported through intentional leadership that gently pressures and nurtures teachers.” (p. 128). During the MSP teachers are being given a variety of “tools” to teach science, but what are they doing with these tools?

The purpose of chapter four is to present the results from the research as it relates to themes that were mined. This chapter is divided into two parts, an overview of the study and study findings. The findings have been synthesized to produce common themes from different cases to answer the research questions. Gall and colleagues (2007) stated that the case study is an involved study of an occurrence in its true to life context which indicated the viewpoints of the participants working with the phenomenon and in the directions it may lead the research. This study highlights the perspectives and experiences of participants regarding the transfer of the MSP into classroom practice, spotlighting effective elements and teacher perceptions about the culmination of two years of learning.
Restatement of the Problem and Purpose

A review of the literature revealed a problem: elementary teachers have a limited science background and are largely unprepared to effectively teach science concepts to their students (Lee & Luykx, 2005). This deficiency in preparation is frequently combated through participation in science professional development. The purpose of this study was to investigate how participation in a sustained professional development improves teacher self-efficacy in science instruction and how it motivates teachers to incorporate elements of the training into their classroom instructional practices. This study considers the perspectives of forty-nine practicing elementary teachers as they participate in a sustained professional development over a two year period. Educators know that participation in professional development that increases content understanding and the ability to decide when and how to present content to students is critical. But having content knowledge and pedagogical content knowledge are only part of what it means to be an effective teacher (Tweed, 2009). This philosophy led this case study to explore how teachers applied, or did not apply, what they learned during the MSP.

The goals of professional development need to be grounded in research to frame the important issues of teaching and learning within the context of the school (Zepeda, 2008). Teachers do not want to waste their time “sitting in a workshop” that has little relevance to their daily work. There were two main goals for this study: (a) to examine the impact of the sustained professional development on teacher self-efficacy and (b) to explore the elements of the professional development that motivated teachers to incorporate science instruction into classroom practice. The researcher used an analytical lens to study the experiences of the teachers longitudinally over the course of this study. This research study was intended to
identify the most successful elements of the sustained professional development and their relationship to teacher self-efficacy in science.

The results are described using themes which surfaced when data sources were triangulated. The data sources included the observations, focus groups, and questionnaires. This information was then organized around the research question and sub-questions used to guide the study:

- **Research Question 1**: What are the effects of a federally funded professional development program on elementary teachers who teach science?
  - **Sub-Question 1a**: What elements from the professional development motivated teachers to incorporate science instruction into classroom practice?
  - **Sub-Question 1b**: What effects did the sustained professional development have on participant self-efficacy as science instructors?

**Organization of Data**

The data were revealed in relation to the themes that emerged during the data analysis. The technique of thick description was utilized to give information concerning the results and to expose themes that emerged from different sources of data. Gall and others (2007) explained thick description as an accurate representation of the phenomenon in the case study utilizing accounts that reconstruct and incident in context with the perceptions and meanings being part of the circumstance. In creating a thick description the researcher examines the data for concepts which organize the information and connect it to other research found in the literature. Thick description also adds to the transferability of the study: as Gall et al. (2007) explained, full details enable generalizability to different settings, people, and circumstances.
Ary et al. (2006) posited that case studies typically do not have transferability, but the researcher is “responsible in providing sufficiently rich, detailed, thick descriptions of the context so potential users can make the necessary comparisons and judgments about similarity and hence transferability” (p. 507). This type of description makes it possible for the research to denote social and cultural designs and place the information in proper context. Yin (2009) agreed that facts and data from the participants being studied through different sources of data support credibility. The use of participants’ narratives and viewpoints regarding actual situations will supply authentic, thick descriptions and hence, dependability. The forty-nine teachers surveyed, observed, and interviewed all proved such details.

Summaries of findings, quotes from participants, diagrams, and observations reported in the study are part of the picture painted by the results of the study coming together. Analysis of the data generated by these narrative and visual sources were reviewed as one unit to allow systematic connections. Statistical findings were submitted in tables and graphs (Ary et al., 2007; Creswell, 2007). Descriptive statistics were used to understand the full implications of the statistical data (Bogdan & Biklen, 2007). Clear themes emerged as these data were analyzed. In this chapter each theme will be discussed separately. Then, in chapter five, the findings for the research questions are discussed based on the themes that surfaced.

Data analysis involved a fluid process. Once all data were collected, the task of data analysis began. First, the researcher interpreted the teachers’ experiences throughout the MSP through a theoretical lens that took into account the design and content delivered during the professional development, the complexity of science instruction itself, and the way the teachers reported transferring their learning into their classroom practice. Second, an interpretive approach was employed in order to clearly understand the elements of the MSP science
instruction that were implemented at the classroom level through the eyes of the teachers. Pattern matching was used to examine the data. Lastly, coding protocols formed the foundation for themes emerging from the case study (Creswell, 2009). The coding protocols included (a) organizing data into initially broad categories with in the data sources, (b) clustering data into categories of developing themes in data sources, (c) grouping data into categories across the different data sources, (d) revisiting and discussing the data to look for clarification of information, (e) building confirmability by reaching consensus with critical friends regarding themes which surfaced from the data sources, and (f) ensuring reflexivity by participants to achieve reliability of themes across all data (Blanks, 2001).

The data were classified by color codes. The researcher utilized different colors for data from each year of the MSP. Notes regarding themes that emerged were written in a different colored font to differentiate the source of the data and year collected. The organization of color coded data prevented confusion, ensured accuracy in reporting the data, and helped with an in-depth analysis. During the coding process, the breakdown into separate colors helped the researcher stay focused.

Participants

The participants for this study were third grade teachers who applied to be part of a two-year Math Science Partnership (MSP) professional development. The MSP was awarded to Kennesaw State University, KSU. KSU partnered with eight different school systems in Northwest Georgia. The participants were selected from these eight school systems based on an application they completed (Appendix D). Participants were purposefully selected based on criteria and a selection rubric (Appendix E). Forty-nine teachers representing forty different schools were ultimately selected to participate. The participants were part of two cohorts that
participated in the two years of the MSP professional development. On different occasions, such as fieldtrips, the cohorts met jointly.

**Instrumentation**

Data collection was achieved by various methods and instruments over the course of two years, so triangulation of data could be carried out. Multiple sources of data made triangulation possible. Triangulation of the data between focus groups, observations, questionnaires, and the pre-/post-STEBI provided dependability and credibility in the research results. The key data came from the focus groups and questionnaires. In this study, not only did the different sources of data add to the triangulation, but participants represented third grade teachers at thirty-eight different elementary schools.

Each piece of data was collected digitally or transcribed into a digital format by an outside evaluator. Participant identifiers were removed and digital files were shared with the researcher. The researcher reviewed the files and labeled each piece of data. After a thorough review of the data, consistent themes were identified. The results were structured to indicate how the experiences of the participants related to each theme through the words and actions of the participants. Once the themes were fully supported by the information collected from the various sources in the study, the research questions could be answered.

**Science Teaching Efficacy Belief Instrument (STEBI)**

Participants completed the STEBI prior to participating in the MSP. The STEBI was completed again at the end of year 1 and upon completion of year 2 of the MSP. Enochs and Riggs (1990) created the Science Teaching Efficacy Belief Instrument, STEBI, to investigate the self-efficacy and beliefs of teachers regarding science instruction (Appendix I). The STEBI is a 25-item instrument containing items such as, “I am typically able to answer students’ science
questions.” Teachers indicate that they either agree or disagree with by choosing from a 5-point Likert scale. The pre- and post-STEBI scores were compared using a paired $t$-test to determine if there was a significant difference in the self-efficacy means.

The STEBI is measured using two scales, illustrated in Figure 2, personal science teaching efficacy belief and science teaching outcome expectancy. For the purposes of this study, the items on the personal science teaching efficacy belief scale were compared. These data were collected by the outside evaluator. The outside evaluator collected and coded participant names with numbers to ensure participant anonymity. Ary et al. (2007) and Bogdan and Biklen (2007) recommended descriptive statistics be drawn on to explore the basis of the participants’ experiences. The mean, standard deviation, and paired $t$ tests were calculated to determine if any relationships were statistically significant, as well as if the participants reported increased self-efficacy in science as a result of participating in the MSP.

Figure 2 STEBI Question Distribution For The Self-Efficacy And Outcome Expectancy Scales.
Questionnaires

A summative questionnaire was given to participants at the culmination of years 1 and 2. The questionnaires, (Appendix F), contained five open response questions. Participants were provided the opportunity to respond in a narrative form. The questionnaires were distributed and the data were collected digitally by the outside evaluator. All questionnaire data were shared with the researcher after participant identifiers had been removed. A numerical coding system was used by the outside evaluator to match participant responses from each year. These data were also coded by cohort. Participant responses from the north cohort were separated from the responses of participants in the south cohort. This separation afforded the researcher an additional point of triangulation of data between the two cohorts.

The critical data collected from the questionnaires were those were teacher participants reported the components of the MSP they found most beneficial and were using in their classrooms. Participants were familiar with providing their input regarding what was and was not effective during the MSP. At the end of each day of training, participants completed short formative assessments where they expressed which elements of the day’s training were most beneficial or useful and which elements were least beneficial or confusing. MSP instructors adjusted instruction daily based on the daily feedback from participants. Instructors worked hard to develop a mutual sense of trust and comfort between the participants and the instructors. As a result, the participants were forthcoming with feedback and information when asked.

Focus groups

Teachers were asked to participate in two different focus groups, (Appendix H) over the course of the MSP. Selection of participants was random and occurred on a day that participants were attending a MSP session. Each focus group session was facilitated by an outside evaluator.
and lasted approximately one hour. The sessions were audio-taped and transcribed by the outside evaluator. Marshall and Rossman (2006) note that the use of focus groups has been widely adapted to include social science and applied research. The focus group method assumes that an individual’s attitudes and beliefs do not form in a vacuum: People often need to listen to others’ opinions and understandings to form their own (Marshall & Rossman, 2006). The advantages of focus group interviews is that this method is socially oriented, studying participants in an atmosphere that is more natural and more relaxed than a one-on one interview. The format allows the facilitator the flexibility to explore unanticipated issues as they arise in the discussion. Focus groups are particularly useful when combined with observation data (Creswell, 2006).

**Observations**

Another critical piece of data came from the observations in the classroom, allowing the phenomenon to be seen in its natural setting, which is central to any case study. Each observation was conducted by appointment with the teacher and carried out by the outside evaluator. Each observation lasted forty-five minutes. An observation protocol, suggested by the Georgia Department of Educator MSP office, was followed in the same manner for each teacher (Appendix G). The use of the observation protocol enabled observations of the science instruction in action in the classroom with students, instead of an experimental model. The protocol collected data regarding student engagement, application of content from MSP, and use of best practice strategies. The outside evaluator recorded her observations on a hard-copy of the observation protocol. Additional antidotal notes regarding teacher self-efficacy as evidenced through rapport with students, comfort with being observed, evidence of lesson/instruction being typical or atypical, artifacts – such as science notebooks, student work, anchor charts, etc., in the
classroom were also included in the comments section of the observation protocol. These notes were transcribed by the outside evaluator into a digital format with the observation data separated by participant. Study themes emerged from these data.

**Results: Themes**

From the data supplied by the different instruments four themes clearly stood out in the experiences of each participant: (a) teacher understanding of science content & pedagogy, (b) increased access to materials and resources, (c) benefits of collaboration with peers, (d) improved self-efficacy in science. All four themes are interconnected through the reflections and experiences of the participants. Subsequent analysis of each theme independently revealed a relationship with each other and the last theme, self-efficacy. These findings are illustrated in Figure 3 below and will be discussed in greater detail in this chapter. The results of the

![Figure 3. Relationship among the themes revealed during data analysis](image)

questionnaires, focus groups, observations, and STEBI clarified, reinforced, or connected
information gathered in the study. Each data venue from each participant helped to add threads to the information, which aided in comprehending what happened over the course of participating in the MSP. Ultimately, the different threads came together to complete a tapestry depicting the effect of sustained participation in the Math Science Partnership.

**Theme One: Teacher Understanding of the Science Content and Pedagogy**

One of the primary criteria used to select teachers to participate in the MSP professional development was a perceived deficiency in science content knowledge. The premise behind this study was if teachers were provided with quality science professional development over two years, they would be more successful in providing quality science instruction. Michaels et al. (2008) shared that what a teacher knows about science influences the quality of instruction and has a powerful effect on the success and type of discussions that teachers can engage in and sustain with students. A review of participant responses related to theme one, science content and pedagogy, revealed six sub topics. These sub topics are illustrated in Figure 4.

**Figure 4.** Sub topics revealed during the review of theme one content and pedagogy
Since the themes of this study are drawn from the patterns in the data, diagrams are included so that readers can interpret these patterns as they see fit. The review of literature revealed a lack of conceptual understandings of basic science content knowledge by many elementary teachers (Duschel et al., 2007; Rice, 2005). This combined with a lack of preparation in effective science pedagogical methods resulted in many teachers dismissing or disregarding inquiry as irrelevant and inconvenient. Study data illustrated in figure 4, indicate that participation in the MSP enabled participants to improve their understanding and application of science content and best practice pedagogy.

The questionnaires administered to participants and the focus groups conducted during years one and two of the MSP asked teachers to reflect on the most beneficial aspect of the professional development. Table 2 illustrates, common responses from participants regarding an increase in their understanding of science concepts and pedagogy related to grade level specific learning expectations for students or Georgia Performance Standards (GPS).

Table 2

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>I learned more information on heat than I even realized I needed! I understand how students might view some of the questions and content we are teaching that we might not realize.</td>
</tr>
<tr>
<td>22</td>
<td>Gaining a deeper understanding [of] the concepts in science.</td>
</tr>
<tr>
<td>28</td>
<td>The in depth knowledge about rocks and minerals. I feel like a rock and mineral expert!</td>
</tr>
</tbody>
</table>
To get a better understanding of the Standards. How to take the Standards and go a little deeper with them. Bring more things into each one and not bringing in things that are not supposed to be there.

Wow! I didn’t realize how much I didn’t know. But now thanks to the instructors, I feel far more confident.

Reading through participant responses, it was clear that participants felt they had a stronger understanding of the science concepts they were to be teaching. Participant 28 responded with feelings of being an expert. Similarly, participant 48 indicates increased confidence. These responses reflect an increase in self-efficacy. The improved content knowledge enhanced participant confidence in their ability to effectively teach these concepts to students.

A review of participant responses indicated that they not only understood what they were supposed to be teaching, but they had learned clear examples of how to apply what they had learned back in their classrooms. They felt comfortable applying what they had learned because they had spent time during the MSP modeling and doing the experiments. Table 3 illustrates evidence to support this assertion from participant questionnaire and focus group responses.

Table 3

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>The most beneficial thing about the MSP has been the chance to do hands-on activities before attempting them with my class. Not just being told what to do, but being shown how to do it.</td>
</tr>
<tr>
<td>14</td>
<td>It has also been very beneficial to try out the activities. This [training] has been</td>
</tr>
</tbody>
</table>
very hands-on. We’ve gotten to do it from the students’ perspective, so I felt more comfortable implementing the things that we’ve learned.

16  The activities were interesting and engaging and participating in them makes them attainable and doable.

33  I love the ideas and sharing several activities focusing on one topic. Helped me see how to help my students learn the concepts.

39  I like that you let us wonder and do the experiments.

Over the past 6 years MSP instructors have structured each professional learning session to afford participants the opportunity to do the experiments and labs, not simply watch instructors model experiments. These data, reported in Table 3, supported this practice. After spending time doing the experiments, participants felt the experiments were attainable and doable in real classrooms. This implies teacher learning through investigation and inquiry. Similarly, Guskey (2003) found that the teachers’ content and pedagogical knowledge was enhanced when integrated examples of science teaching. The response shared by participant 33, in Table 3 above, is illustrative of the value of study participant placed on the personal experience of doing each lab.

In addition to affording participants the opportunity to experience labs first hand, MSP instructors also emphasized the relationship among various science concepts throughout the MSP. The instructors referred to the relationships among concepts in the GPS as a tapestry. Prior to participating in the MSP, many of the participants saw the GPS as a series of unrelated science topics they were required to teach. They were unaware of the relationship among the
various concepts taught at each grade level. The recognition of relationships, or cross cutting concepts, in science is a goal of the new Next Generation Science Standards (NGSS) (Duschl, 2012). These crosscutting concepts are meant to give students an organizational structure to understand the world and helps students make sense of and connect core ideas across disciplines and grade bands. The value participants placed on understanding the relationships between various science concepts was a surprising sub topic that emerged during a review of the data. Participants were unfamiliar with the idea prior to the MSP, but began to grasp the significance as the MSP progressed. Table 4 lists a few of the participant responses on the value of recognizing these relationships.

Table 4

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>I liked how they connected what students are learning now to the upper grades. It is important for ME to see how this connects to middle school.</td>
</tr>
<tr>
<td>17</td>
<td>These two weeks have been so valuable. I understand the tapestry, which I have never seen or noticed before.</td>
</tr>
<tr>
<td>19</td>
<td>Clarification about how and what is supposed to be taught as far as the kind of skills students are supposed to get before they get to you and the kind of skills they are supposed to get as they leave you. This was spelled out very clearly.</td>
</tr>
</tbody>
</table>

In Table 4 above, Participant 2 states, “It is important for ME to see how this connects to middle school.” This recognition of the importance to the vertical progression of science
concepts and value the recognition as a result of participating in professional development is significant. A goal of all instruction, not just science, should be to develop students’ conceptual understanding, (Tweed, 2009). It is impossible to help students recognize these connections, if the teachers are unaware they exist. The participants were unaware or had never noticed these connections before. The response from participant 17, in Table 4 above, is indicative of many participant responses on the questionnaires and surveys. MSP professional learning sessions were carefully designed by MSP instructors, to help participants recognize these connections.

The instructors of the MSP cohorts included in this study have co-taught MSP cohorts together for over seven years. Both are veteran educators with 40 plus years and 19 plus years of experience respectively. Table 5 highlights participant comments on the influence the MSP instructors on the experience of participants during the course of the professional development.

Table 5

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Very well organized. I did not feel like I was being talked at. They knew what they were talking about and they are the top in their field. Everything we did is relevant to my job today.</td>
</tr>
<tr>
<td>28</td>
<td>The opportunity to talk to people who are doing the same thing at a higher level. People who have been around, done this, done that and whittled it down to the best means to accomplish our goal. That was really good.</td>
</tr>
<tr>
<td>37</td>
<td>[MSP] has given me the opportunity to have access true professionals in the specific fields that can help clarify things for me or fix misconceptions that I’ve had.</td>
</tr>
</tbody>
</table>
Teachers are the primary clients of professional development. Knowing the client can clinch the success of the professional learning effort, and not knowing the client can guarantee its failure (Loucks-Horsley et al., 2010). Years of classroom teaching experience coupled with district level supervisory experience, afforded the MSP instructors the critical lens of relevance and needs of MSP participants. When introducing a new or challenging concept to participants, the instructors often “played” off one another. One would take on the role of the struggling learner and ask the other to repeat or explain the concept again. Sometimes the instructors would question each other or point out an error that one had made. This put participants at ease and modeled behaviors the instructors wanted participants to imitate. This created a safe teaching and learning environment. Participants were free to ask questions or clarify understandings.

Zepeda (2008) writes that adult learners want to be successful learners who find pleasure and relevance in their learning. She goes on to add that for adults, relevancy adds value to the learning. The MSP instructors considered multiple factors when designing the professional learning sessions ensure relevance. Among these factors were experience levels of the participants, prior experience with professional learning opportunities – science and non-science learning, the most pressing areas for improvement, as well as the current support systems to which teachers have access. It is this last area that leads us into the second major theme revealed in the study, increased access to materials and resources.
Theme two: Increased Access to Materials and Resources

During their educational career, educators are always adding “tools” to their educator toolbox. Figure 4, illustrates to common sub-topics that emerged during an analysis of theme two, materials and resources.

*Figure 4. Sub topics revealed in review of theme two increased access to materials and resources*

No one who plans professional development needs to be reminded about the need for adequate resources, especially time, money, and materials (Loucks-Horsley et al., 2010). One of the fundamental practices of the MSP professional development is to provide participants with the necessary materials to do each experiment modeled. Table 6 details the value participants placed on the resources and materials received during the MSP.
Table 6

*Value Of Resources And Materials Received During The MSP*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>The most valuable part of MSP for me it was getting all of the materials and having all the resources for when you went back. They did not just show us how to do things, they gave us the materials to do those things when we went back to our classrooms.</td>
</tr>
<tr>
<td>32</td>
<td>Fabulous resources to use TODAY in our classrooms. I can't wait to get into the new school year and put all these fabulous things to the test!</td>
</tr>
<tr>
<td>46</td>
<td>The resources given to us were great and not just the purchased items. It was relevant to what I need to know. The sessions were standards and GPS driven.</td>
</tr>
</tbody>
</table>

Conducting and engaging in science explorations requires access to materials and resources. Teachers without adequate access to the necessary tools are limited in the types of learning opportunities they can provide to their students. Participants not only learn about and practice a concept; they also receive the resources and materials necessary to repeat the experience in their classrooms with their students. The responses in Table 6 indicate that participants place a high value on materials they deem relevant to their current teaching position. These are materials they can use immediately with their students. Teachers are often burdened with so many responsibilities that they struggle to find time to adequately prepare hands on science experiments.

Providing teachers with the necessary materials and resources removes a large barrier to implementation of the new strategies they have learned. This assertion is supported through the
observational data collected in this study. Table 7 reveals the frequency with which study participants were observed using the resources and materials supplied during the grant during.

Table 7

<table>
<thead>
<tr>
<th>Classroom Observational Data MSP Materials And Resources Being Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence of Use</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>45 Classrooms</td>
</tr>
</tbody>
</table>

Table 7 brings more key information to the data story for this case study. Forty-five, or 90%, of the forty-nine MSP teachers observed were using materials and resources obtained during the grant. Of the resources and materials observed being used, two appeared with greater frequency than all others. These were the use of Activities Integrating Math and Science (AIMS) lessons and interactive notebooks.

These findings are congruent with questionnaire responses from years 1 and 2. Participants were asked to list two things they learned from MSP that there were going to implement back in their classrooms. This question was presented in an open response format. Participant responses ranged from general comments about content knowledge to specific strategies (e.g. carousel, foldables, etc.) to listing the names of experiments modeled during the MSP sessions. During an analysis of participant responses the same two resources, interactive notebooks and AIMS lessons, appeared with greatest frequency. Both of these resources utilize an interdisciplinary or integrated approach to learning.

The strength of the AIMS lessons lies in the integration of different disciplines into each lesson. Meaningful integration of knowledge is a major recommendation coming from the nation’s professional science and mathematics associations (Koba & Wojnowski, 2013). The
AIMS foundation has conducted extensive field testing of AIMS investigations. The AIMS model of learning has a heavy emphasis on doing something with or to concrete objects. The AIMS Foundation (2007) believes this emphasis provides students with, “something other than the tip of their pencil with which to think.” (p. 285.)

On day one of MSP, participants were given a composition book. This book, more than any other resource given, became a record of their learning. Interactive science notebooks were modeled and used in each MSP session throughout the two years of the grant. Table 8 displays some of the participant responses regarding the value of interactive notebooks.

Table 8

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Liked how we actually made the interactive journal. Never made them before so it was nice to get to do the hands on making one.</td>
</tr>
<tr>
<td>12</td>
<td>I am using the notebooks for science. The kids like them. They wrote about their experiments, drew the results. It took a while to get the folding stuff. By the end of the year they were doing it easily. They liked looking back at their work. I’ll do it again.</td>
</tr>
<tr>
<td>21</td>
<td>I liked that we did the interactive notebooks like we expected the kids to. I could go back and refer to it and show the children this is how I did it, and they really liked to show me up.</td>
</tr>
</tbody>
</table>

At the end of the MSP, participants left with a complete concrete record of their thoughts, sample strategies, formative assessments, personal reflections and more in their interactive
notebooks. What made the interactive notebooks so valuable to participants was that each participant created their own. The notion of journaling in science is not new. What is new is the format employed in the interactive notebooks. Participants were being shown how to incorporate all the different teacher tools they were learning – quick writes, unpacking standards visually, graphic organizers, foldables, drawing, and more into a single resource. They were given the opportunity to practice and refine the incorporation of these tools in the interactive notebooks over the course of the two years. Teachers who approached the project with trepidation at the start were using the interactive notebooks with ease at the end of the MSP.

Interactive notebooks were relevant to the current needs of the MSP participants. Hewson (2007) found that professional developments are most successful when they are tailored to the specific circumstances and meet the needs of those in attendance. The participants in this study were all elementary teachers implementing the new Common Core Standards for English Language Arts. These new standards called for teachers to incorporate more informational writing. The interactive notebooks afforded participants an opportunity to accomplish this goal, while simultaneously engaging in authentic science processes, such as recording information and data and engaging in research, collaboration, and analysis (Hargrove & Nesbit, 2003; Young, 2003).

The implementation of the Common Core standards may have also been a factor in the final sub-topic that emerged, literature connections. MSP instructors incorporated literature connections into each professional development session. The participant responses in Table 9, illustrate the usefulness of providing participants with pieces of literature connected back to the science concepts being taught.
Table 9

*Usefulness of Literature Connections provided during the MSP*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>I love all the literature connections and having ideas on how to incorporate the CCGPS.</td>
</tr>
<tr>
<td>14</td>
<td>I appreciate the trade books used to connect students to the lesson - (literatures).</td>
</tr>
</tbody>
</table>

The MSP instructors paired engaging fiction books, poems, and reader’s theater pieces with nonfiction books, web resources, and other informational sources to compliment the science content being presented. This format was well received and appreciated by the participants as evidenced by participant responses found in Table 9. Research suggests that science textbooks can be overwhelming for many children, especially those who have reading problems (Douglas et al., 2006). Ansberry and Morgan (2010) point out textbooks often contain unfamiliar vocabulary and tend to cover a broad range of topics. However, fiction and nonfiction children’s literature books tend to focus on fewer topics and give more in-depth coverage of the concepts. There is a wide array of high-quality children’s literature available to help teachers model reading comprehension strategies while teaching science content in a meaningful context. Many children’s literature books, have interesting storylines that can help students understand and remember concepts better than they would by using textbooks alone, which tend to present science as lists of facts to be memorized.

**Theme Three: Collaboration with Peers**

The third theme that emerged from a review of data was the importance of the opportunity to engage in collaboration with peers. Learning how to teach is an ongoing and
interactive practice. Encouraging learners to share their ideas can lead to rich discussions about science content. These social interactions can play a critical role in the development of scientific understanding because they often mirror a level of discourse that occurs naturally in science and reflects appropriate communication (Darling-Hammond, 2008). Figure 5 illustrates the sub topics revealed during a review of theme three, collaboration with peers.

**Figure 5.** Sub topics revealed during the review of theme three collaboration with peers

While clear research exists to supports professional development efforts that allow for teacher collaboration and collective participation (Darling-Hammond et al., 2009; Garet et al., 2001; Supovitz & Turner, 2000; Weiss & Pasley, 2006), the researcher was surprised by the emergence of theme three as one of the top benefits of participating in the MSP. A review of participant responses related to theme three, collaboration with peers, revealed five sub topics. These sub topics are illustrated in Figure 5. Common survey and focus group responses from
participants regarding the benefits of collaborating with peers throughout the professional development have been included in Table 10.

**Table 10**

*Benefits of Collaborating with Peers During MSP*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>Networking and meeting other teachers and sharing ideas and hearing about other ways teachers present the same materials. It was very helpful to be clustered with 3rd grade teachers. We go to so many different professional developments that are kind of an umbrella of elementary and it’s nice to be learning about my grade level.</td>
</tr>
<tr>
<td>29</td>
<td>Working/sharing with colleagues who struggle with the same things you are struggling with in your classroom</td>
</tr>
<tr>
<td>35</td>
<td>Through meeting teachers at MSP, I can now go outside my school for additional help. To email one of the teachers here to ask for help. That was so empowering! So I didn’t feel like I am stuck and having to manage other stresses.</td>
</tr>
<tr>
<td>46</td>
<td>It’s made me a better teacher. I’m more enthusiastic and excited about teaching math and science now that I’ve had this experience and being exposed to different teaching and people in the cohort. It has very much improved my confidence level.</td>
</tr>
</tbody>
</table>

Throughout the course of the MSP participants were challenged to learn new content, recognize that they had common misconceptions, and that sometimes, they had been teaching a concept incorrectly. Participant 29, listed in Table 9, stated that working in a group of peers who
were struggling with the same things was beneficial. The homogenous design of the MSP cohort afforded participants the opportunity to interact with their grade level peers. Additionally the selection of participants with similar teaching experiences strengthened similarities among participants. These similarities coupled with the variety of different school settings among participants created a harmonious balance of uniformity and diversity of experiences and practices. Darling-Hammond (2008) notes that teachers, like students, needed a safe environment to explore their own ideas and thinking without fear of ridicule or sanction. Careful screening and selection of participants established a cohort of teachers of like readiness levels, needs, and challenges.

The MSP participants were asked to adopt new practices that were in many cases, substantially different from their traditional notions about teaching science. In one of the focus group sessions a participant shared,

“As a new teacher, to be able to collaborate with veteran teachers and being real with one another. This worked for me or I will try something different next year and not using that politically correct image. For example, doing the foldables was a struggle for me. I was elated to hear that and know it was not just me. I can take it back to the classroom with realistic expectations.”

Another focus group participant expressed,

“A lot of time we have workshops and we get things, but finding the time to take it back and implement it in our classroom -- when we do get the time, we find that we have forgotten what we learned about. And this has not been like that. They’ve shown us, they’ve given us the resources, and we’ve been able to go back and implement it.”

When learning new techniques and practices, participants needed time to be learners themselves. This means that MSP leaders had to provide teachers with collaboration opportunities to talk about their learning and time for learning to occur in the company of others. This went beyond casual exchanges in the hallways or during breaks. The teachers need to be involved in “animated conversations about important intellectual issues” (Prawat, 1992, p. 13 as cited in
MSP sessions were structured to allow participants to work in collaborative groups to do an experiment or activity. The groups worked together to understand the concept, collect data, and complete the lab accurately. MSP leaders spent ample instructional time discussing the activity, potential problems that could occur in the classroom, clarifying understanding, and listening to the ideas/suggestions of other MSP participants. This practice was well received as evidenced by this participant response, and those listed in Table 9.

They gave us the opportunity to do it ourselves while we are here. Sometimes we go to workshops, and you get stuff, you try it, and you find yourself with all kinds of difficulties. But you figure that out here. Then we have time to collaborate and figure out a way that it will work best. That practical time has been very helpful.

The opportunity to network with grade level peers from different schools is not a common occurrence in education, despite ample research to support the practice (Koba & Wojnoswski, 2013).

The themes discussed thus far, (1) teacher understanding of science content & pedagogy, (2) increased access to materials and resources, and (3) benefits of collaboration with peers all support the final theme that emerged from a review of the data: improved science self-efficacy.

**Theme Four: Improved Self-Efficacy in Science**

Self-efficacy related to science instruction is the belief a person holds in their ability to effectively teach science concepts to students. Descriptive statistics were employed to provide a complete data story concerning the impact of self-efficacy on MSP participants included in this study. A t-test was applied to the pre and post STEBI scores to determine if there was a significant difference between the means of the pretests and the posttests. There was a significant difference between the pretest and posttest means on the STEBI (Pretest mean = 46.93, n = 49, SD = 6.21, Posttest mean = 49.51, n =49, SD = 4.85, t = 2.46, p < 0.01). A comparison of the
pretest and posttest means indicated that significant improvement was found in self-efficacy. These results are summarized in Table 11.

Table 11

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Mean</th>
<th>Standard Dev.</th>
<th>t value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEBI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>49</td>
<td>46.93</td>
<td>6.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posttest</td>
<td>49</td>
<td>49.51</td>
<td>4.85</td>
<td>2.46</td>
<td>p&lt;0.01</td>
</tr>
</tbody>
</table>

As the data story unfolded, it revealed that the study participants did show statistically significant progress in self-efficacy, which was a goal of the MSP. These statistically significant findings indicate that participation in the MSP, a sustained professional development, improved the science self-efficacy of participants.

A review of the data revealed that self-efficacy was a noteworthy factor in the transfer of professional learning into classroom practice. To illustrate this assertion quantitative data in the form of descriptive statistics from the administration of the STEBI were analyzed alongside qualitative data from the questionnaires and focus groups. Deeper analysis of the STEBI data revealed three questions in particular that showed the greatest gains over the course of the study. The three questions with the highest gains from the self-efficacy scale on the STEBI are listed in Table 12.
Table 12

**Self-Efficacy Scale Questions from STEBI with Highest Gains**

<table>
<thead>
<tr>
<th>Question</th>
<th>n</th>
<th>Pretest Average Mean</th>
<th>Posttest Average Mean</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q5. I know the steps to teach science concepts effectively.</td>
<td>49</td>
<td>3.74</td>
<td>4.37</td>
<td>+0.63</td>
</tr>
<tr>
<td>Q19. I wonder if I have the necessary skills to teach science.*</td>
<td>49</td>
<td>3.62</td>
<td>4.19</td>
<td>+0.57</td>
</tr>
<tr>
<td>Q23. I don’t know what to do to turn students on to science.*</td>
<td>49</td>
<td>3.74</td>
<td>4.31</td>
<td>+0.57</td>
</tr>
</tbody>
</table>

*Scale used to calculate mean was inverted to adjust for negative wording of question.

Feelings, thoughts, motivation, and behaviors have a definite impact on classroom instruction. Bandura (1986), stated that self-efficacy beliefs determine how people feel, think, motivate themselves and behave. Earlier in this chapter, the researcher described themes that emerged from reviewing the data. Triangulation of these data along with the STEBI data will strengthen assertions previously made. There was a strong alignment of participant responses to all three questions highlighted in Table 12. STEBI question 5, listed in Table 12, supports the findings from theme one: teacher understanding of science content and pedagogy. Prior to participating in the MSP, 30% of participants disagreed or provided a neutral response regarding their perceived ability to teach science concepts effectively. At the end of the MSP, 98% of participants agreed or strongly agreed that they knew the steps to teach science concepts effectively. As cited previously, a review of participant responses, see Tables 2, 3, and 4,
indicated that they not only understood what they were supposed to be teaching, but they had learned clear examples of how to apply what they had learned back in their classrooms.

Participant access to clear examples and resources to teach science was discussed during an analysis of theme two: increased access to materials and resources. A review of the data indicated that participants found substantial value in the materials and resources they received during the MSP. Question 19, listed in Table 12, provides additional support to these findings. This question seeks to have participants evaluate their perceived science teaching skills. During the administration of the STEBI pretest, 30% of participants indicated perceived lack of necessary skills. On the posttest, 87% of participants indicated that they agreed or strongly agreed they had the skills necessary to effectively teach science. These findings are further supported through participant responses on question 23 of the STEBI. On question 23 of the STEBI pretest, 30% of participants were unsure how to “turn students on to science.” On the posttest for the same question, 94% of participants indicated confidence in their ability to turn students on to science.

Motivating and inspiring students to enjoy science requires teachers who themselves have been “turned on to science.” In a focus group session on participant shared,

“It’s made me a better teacher. I’m more enthusiastic and excited about teaching math and science now that I’ve had this experience and being exposed to different teaching and people in the cohort. It has very much improved my confidence level.”

The themes discussed earlier in this chapter provide a data story to show how the MSP participants increased their science content and pedagogy skills, received materials and resources to take back to their classrooms to practice and refine these skills, and developed a network of peers to support them in the future. All of these factors combined to improve participant self-efficacy in science.
CHAPTER FIVE: CONCLUSIONS

I embarked on this study to investigate the effects of sustained professional learning on the classroom practices of elementary teachers. Specifically, which elements of the professional development did participants find most beneficial. I followed forty-nine elementary teachers for two years as they participated in a Math Science Partnership (MSP) professional development aimed at improving their science content and pedagogical knowledge. The teacher participants’ reflections, observations, and stories from their own lived experiences during the professional development and in the classroom came together in a tapestry of information which helped guide the research. This study went further by including statistical data on the changes to participant self-efficacy related to science instruction over the course of two years. Weaving in statistical data added another level of complexity to the image created by the study. This study strived to create a panel in the tapestry of elementary education by showing methods to support practicing classroom teachers as they work to include quality science instruction in their daily practices.

This chapter will first present an overview of the study, a summary of results, recommendations, limitations and delimitations, along with implications for practice and future research.

Overview of Study

The purpose of this study was to investigate how participation in a sustained professional development, the MSP, improves teacher self-efficacy in science instruction and how it motivates teachers to incorporate elements of the training into their classroom instructional practices. This study considered the perspectives of forty-nine practicing elementary teachers as they participate in a sustained professional development over a two year period. This research study was intended to identify the most successful elements of the sustained professional
development and their relationship to teacher self-efficacy in science. This study showed that participation in the MSP had a direct impact on daily classroom science instruction.

The style of research chosen to stitch this intricate picture was a case study approach. Case study research should take place in the natural setting of the phenomenon being studied. Honig (2006) stated, “Despite concentrated efforts to produce specific outcomes, policy makers frequently neglect to consider ways in which prior reform policies, school contexts, and individual teacher characteristics interact to produce both intended and unintended consequences” (p. 201). This sentiment was repeated through much of the literature on curriculum narrowing or the unintended consequences of reform acts such as NCLB (Rennie Center for Educational Research & Policy, 2008; Shymansky, Yore, & Anderson, 2004; Hart & Lee, 2003; Center on Organizing and Restructuring Schools, 1993) and the significant design limitations of elementary teacher preparation programs (Rennie Center for Educational Research & Policy, 2008). The elementary science classroom is vastly different from their middle and high school counterparts. It is important to investigate the needs of elementary science teachers, with their unique contexts and backgrounds, separately from the needs of science teachers at other levels.

There were two main goals for this study: (a) to explore the elements of the professional development that were transferred into classroom practice and (b) to examine the impact of the sustained professional development on teacher self-efficacy. The researcher used an analytical lens to study the experiences of the teachers longitudinally over the course of this study. Data were collected from participant focus groups, classroom observations, participant questionnaires, and Science Teaching Efficacy Belief Instrument, or STEBI throughout the two year
professional learning. These data were utilized to provide a more comprehensive look at the evolution of science self-efficacy and practices over the course of the MSP.

By nature, qualitative research offers many discoveries during the twists and turns of the data collection from lived experiences in their natural context. The findings revealed in Chapter Four were from the data provided through the different instruments of research utilized in this study. Yin (2009) stated that a key objective of case study research is to see how the information comes together during the study to answer the research questions. The purpose of this chapter was to offer a summary in the form of the answers to the research questions and recommendations and implications based on these results.

Summary of Results

The study results indicated that the MSP professional development program was effective in improving teacher self-efficacy in science, as scores on the STEBI increased at statistically significant rates over the course of the two years. A more detailed analysis of these results revealed that the STEBI questions with the highest gains were focused on improvements in science content and pedagogical knowledge. Qualitative data from participant questionnaires, focus groups, and observations corroborated the STEBI findings about improved teacher content and pedagogical knowledge in science. In addition to the themes of improved teacher content and pedagogical knowledge in science, three other themes clearly stood out in the experiences of each participant. These were (a) increased access to materials and resources, (b) benefits of collaboration with peers, and (c) improved self-efficacy in science. Detailed discussions regarding each theme will be addressed next.
Research Questions

The literature review provided a solid foundation of the theories behind professional development and aspects of effective professional development. A much smaller number of studies focused on components of effective science professional development (Hewson, 2007; Louchs-Horsley & Matsumoto, 1999; Louchs-Horsley et al., 2010; Michaels et al., 2008). The review of literature also found an abundance of research on improving the self-efficacy in science of pre-service teachers (Marshall et al., 2009; Supovitz & Turner, 2000; Enochs & Riggs, 1990), but a significant lack of research with practicing or in-service teachers. The research conducted with practicing teachers primarily focused on gains in content knowledge measured by standardized assessments (Hewson, 2007). The research questions of this study were developed to learn more about the changes to classroom practice of practicing elementary teachers.

**Research Question:** What are the effects of a sustained federally funded professional development program on elementary teachers who teach science? The overarching nature and potentially broad interpretation of this question led the researcher to develop two sub-questions to focus the research on two specific effects of the professional development, participant self-efficacy, and the incorporation into classroom practice.

**Research Question 1a:** What elements from the professional development motivated teachers to incorporate science instruction into classroom practice?

**Research sub question 1b:** What effects did the sustained professional development have on participant self-efficacy as science instructors? There were four themes which emerged from a review of the study data. A visual representation of each theme and the relationships among the themes can be found in Figure 6: Effects of Sustained Science Professional Learning.
Figure 6: Effects of Sustained Science Professional Learning.
The experiences of participants in this study revealed that participation in a sustained professional development (a) improved participant understanding of science content and pedagogy, (b) enabled participants to apply what they had learned by providing access to necessary materials and resources, (c) enabled participants to develop a science support network of peers, and (d) improve their science self-efficacy. Study findings related to each sub-question will be addressed in greater detail in the subsequent sections.

**Research Question 1a: What elements from the professional development motivated teachers to incorporate science instruction into classroom practice?** The four themes pictured in Figure 6 comprised elements which when combined, motivated teacher participants to incorporate newly learned practices into their daily classroom instruction. In this section I will describe each theme.

**Theme one: Science Content and Pedagogy.** Prior to starting the MSP one participant wrote, “My weakest area as a teacher is science. I try hard to make it interesting but the biggest challenge is that at times I feel that I don't actually have the depth of knowledge required to help my students exceed in that area.” Another said, “I am challenged when it comes to the science content, especially matter and electricity. I study up on it before I teach, but I am lacking the deep understanding for exceptional pedagogy.” Similar sentiments were echoed by many participants prior to beginning the MSP. This study found that in order to improve teacher content and pedagogical knowledge participants must be afforded the opportunity to learn both – content and pedagogy - simultaneously and not in isolation. Content instruction provided separately from appropriate elementary pedagogy lacks a clear and relevant connection to the classroom. Teachers need to apply their knowledge of science differently from the way that scientists do. A scientist understands scientific theory and its historical origins, the questions
being investigated, and the ways in which questions are investigated in his or her field. But a scientist does not necessarily know how to convey scientific knowledge to children or other non-experts, or how to create appropriately structured opportunities for practicing science (Locks-Horsley et al., 2010). This speaks to the need to help teachers learn relevant science content partnered with effective pedagogical techniques. A teacher without a firm grasp of science content lacks the self-assurance or confidence necessary for the successful implementation of quality science instruction. These findings are supported by a study conducted by Reeves et al. (2010) which found that teachers with increased content and pedagogical knowledge would be empowered to provide more effective implementation. Similarly, Michaels et al. (2008) revealed that effective science teachers engage in an internal dialogue between disciplinary science goals and the pedagogical means of determining what children know and how to move their understanding forward. It is the unique marriage of content and pedagogy over time that enabled study participants to develop and refine the skills necessary to effectively teach relevant science concepts.

Science professional development is most effective when it is modeled and focused on relevant science standards (Koba & Wojnowski, 2013; Loucks-Horsley et al., 2010). Study participants reported that MSP instruction focused on relevant grade level standards modeling the use of pedagogically sound practices by providing teachers with the support necessary to implement what they were learning in their classrooms. MSP instructors designed each session around state grade level science learning objectives or standards. Participants were able to take on the role of students. They completed each lab as students, then debriefed about what transpired using their teacher lens. This structure was designed to enable participants to view an experiment using a student lens and teacher lens to foster a deeper understanding of the entire
Participants reported that the time spent modeling and doing each lab or activity was invaluable. “I love the ideas and sharing several activities focusing on one topic. It helped me see how to help my students learn the concepts”, (Table 3). These findings are congruent with research conducted by Loucks-Horsley et al. (2010) which reveals that science professional developments are most successful when they are planned as a set of coherent strategies to develop content and pedagogical knowledge about both what to teach and how to students learn that content. Similarly Supovitz and Turner (2000) reported that the learning gains are stronger when the professional development is embedded in practice.

Learning about a new experiment became more than understanding a series of steps to complete an activity. The teachers were able to experience first-hand the uncertainty, exhilaration, and sense of wonder each experiment was designed to produce. The research confirms the importance of treating teachers as professionals, generating their own understandings (Darling-Hammond et al., 2009; Garet et al., 2001; Kennedy, 1999). The most successful professional development programs focus not only on teacher behaviors, but also on what to teach and how students learn that particular content (Kennedy, 1999).

Participants in this study increased their content knowledge of grade level concepts in the Georgia science standards. This prepared them to teach these concepts to mastery. MSP instruction also helped participants recognize how these concepts related to content taught in other grade levels. The American Association for the Advancement of Science (1993) articulated a recommended progression of student scientific literacy in their publication the Benchmarks for Science Literacy. This seminal work broke down science concepts into component pieces stating what students should know and be able to do by the time they reach certain grade levels. The current Georgia Performance Standards were written based on these recommendations (Georgia
Department of Education, 2011). The rational for the learning progression was to avoid an overstuffed curriculum that impedes the acquisition of understanding (American Association for the Advancement of Science, 1993). The MSP instructors spent time helping teachers understand the vertical alignment of science concepts in their state science standards through carefully crafted lessons and discussions. The data showed that awareness of the learning progression and vertical alignment of the state science standards helped participants deepen their content knowledge. “I liked how they connected what students are learning now to the upper grades. It is important for ME to see how this connects to middle school,” (Table 4). Participants were aware of the learning boundaries and intent behind the existing GPS science standards. They did not have to wonder if they were teaching the concept correctly or emphasizing instruction on the proper components. They were able to increase the amount of time for science instruction, because they were no longer losing valuable instructional time teaching concepts that belonged in middle or high school. At the same time they were provided the tools necessary to extend the learning when appropriate.

This study also found that sustained professional developments are most beneficial to practicing teachers when the instruction is provided by content experts with elementary classroom experience. MSP instructors, who were content experts with classroom experience, were careful to pair the vertical alignment of content with relevant experiments. The data showed that participants valued instructors who are able to clearly articulate what students need to know and how to help them learn specific science concepts; what particular strategies, examples, and activities can help students at what points in their developing understanding. “The ability to ask questions when I did not understand something and have the questions answered right away [was most valuable],” (Table 5). Professional developments are most effective when they are led by
facilitators with appropriate experience (Weiss and Pasley, 2006). Loucks-Horsley et al. (2010) state that experienced teachers are a rich source of “pedagogical content knowledge.” Teachers learned how to go deeper with various concepts at different grade levels. This knowledge is critical for classroom teachers working to meet the diverse needs of all learners in their classroom.

**Theme two: Increased access to materials and resources.** During their educational careers educators are always adding “tools” to their educator toolbox. From a strategy they learned in a methods course in college to a tip they picked up from a fellow teacher during collaborative planning, educators are always looking to increase their repertoire of educational tools. The reason for this is simple; in the classroom teachers rely on the resources at their disposal to fix problems, design amazing lessons, and craft creative strategies to help students learn. Teachers who have the right resources use them to provide quality instruction to all of their students. Teachers early in their careers or unfamiliar with effective science instruction have access to fewer resources. They have the same desire to design amazing science lessons, but lack the tools necessary to make it happen. These teachers read the chapter on soils from textbook. They were unaware that asking students to bring in a snack size bag of soil from their back yards would yield a variety of soils to observe, and would be much more engaging way for students to learn about the properties of different soils. MSP participants stated and were observed providing their students increased opportunities to engage in a variety of hands-on inquiry learning. Participants described teaching science with greater frequency and doing more hands on learning than ever before in their careers. In a focus group, one participant stated, “For me it was getting all of the materials and having all the resources for when you went back. They [the instructors] did not just show us how to do things, they gave us the materials to do those
things when we went back to our classrooms.” Affording children the opportunity to engage in direct experiences with the physical environment such as watching objects fall or collide and observing plants and animals (National Research Council, 2012). Participants were given the necessary resources and materials to provide their students with opportunities to engage in hands on learning in their science classrooms.

Providing teachers with the necessary materials and resources removed a large barrier to the implementation of the new strategies learned. A review of the data revealed four specific resources and materials that were deemed highly valuable by study participants: (a) receiving materials to replicate experiments modeled in training, (b) Activities, Integrating, Math, and Science (AIMS) lessons, (c) literature connections, and (d) interactive notebooks. As stated previously, one of the fundamental practices of the MPS professional development was to provide participants with the necessary materials to do each experiment modeled. The materials provided ranged from digital scales, meter sticks, magnets, rocks and fossils to posters, websites, videos, specific lesson plans, charts, and books. Far too often teachers attend professional developments and learn about all the great practices that would benefit their students, but leave without the tools necessary to implement in their classrooms. MSP participants were provided materials to replicate experiments in small groups. Participants found the access to hands on science afforded by the materials most useful. They learned about a new lab activity and had the necessary materials to duplicate it with their students.

Study participants indicated that the AIMS lessons and literature connections were beneficial as well. Forty-five or 90% of the forty-nine MSP teachers were observed using AIMS lessons, literature connections, and/or other materials obtained during the professional learning activities. AIMS lessons and literature connections utilize an interdisciplinary or integrated
approach to learning. The rationale for an integrated approach to learning lies in the fact that science, mathematics, language arts, etc., are integrally interwoven in the real world, and should be treated similarly in the classroom. MSP instructors provided participants with AIMS lesson plans and spent class time implementing each lesson from start to finish. In a focus group one participant shared, “We’ve gotten to do it [AIMS lessons] from the student’s perspective, so I feel more comfortable implementing the things we’ve learned.” Participants completed the experiments, collected and analyzed the data, and drew conclusions about the scientific principles being studied, just as their students would. Often MSP instructors would share a piece of children’s literature related to the content of the AIMS lesson. The relationship, similarities and differences, the correct or incorrect information, etc. from the piece of literature would be used as a springboard to learn more about the science content.

A related resource that participants found invaluable, was the interactive science notebook developed throughout the MSP. One hundred percent of the focus group participants indicated that they were using the interactive notebooks with their students. “I liked that we did the interactive notebooks like we expected the kids to. I could go back and refer to it and show the children this is how I did it, and they really liked to show me up.” The participants in the focus groups shared that the interactive notebooks provided an opportunity to integrate, apply, and refine science thinking and language arts skills. Put another way, an interactive notebook provides a space where students take what is inside their brains, lay it out, make meaning, apply it, and share it with their peers, parents, and teachers. Interactive notebooks are a tool students use to make connections prior to new learning, to revise their thinking, and to deepen their understandings of the world around them (Marcarelli, 2010). At the end of the MSP, participants
left with a complete and concrete record of their thoughts, sample strategies, formative assessments, personal reflections and more in their interactive notebooks.

Interactive notebooks had other benefits as well. Participants reported using the interactive notebooks as study guides and in parent conferences. Students took their notebooks home to study and review for tests. Parents appreciated having an organized record of their learning. Findings from this study are supported by existing research regarding the benefits of using interactive notebooks in the classroom. Hargrove and Nesbit (2003) and Gilbert and Kotelman (2005) both found that science notebooks expose students’ thinking, provide important insights about student understandings and serve as formative assessment tools. Amaral, Garrison, and Klentschy (2002) discovered that notebooks provide a structure and support for differentiated learning, helping all students to achieve.

The use of the interactive notebooks and inclusion of literature connections also support scientific practices outlined in *A Framework for K-12 Science Education* from the National Research Council (2012). This document highlights the importance of obtaining, evaluating, and communicating information. The National Research Council’s (2012) *Framework for K-12 Science Education* states:

Science cannot advance if scientists are unable to communicate their findings clearly and persuasively or to learn about the findings of others. A major piece of science is thus the communication of ideas and the results of inquiry – orally, in writing, with the use of tables, diagrams, graphs, and equations, and by engaging in extended discussions with scientific peers. Science requires the ability to derive meaning from scientific texts (such as papers, the internet, symposia, and lectures), to evaluate the scientific validity of information thus acquired, and to integrate that information. (p. 53)
The ability to clearly communicate information is a goal not only of science instruction, but also of English language arts. Reading and writing skills are essential components of scientific literacy. Interactive notebooks provided teachers and students with a location to apply and refine reading and writing skills in context with purpose.

**Theme three: Collaboration with Peers.** Teaching is complex because learning is complex. Developing rote and factual knowledge is simpler than developing in-depth understanding of science concepts (Loucks-Horsley, 2010). Throughout the MSP participants were challenged to learn new content and realize that they, like many adults, had common misconceptions about science concepts. The careful selection of participants and homogenous design of the MSP allowed participants to collaborate with peers of similar experience and comfort level teaching science. The different teaching settings (schools), students (ELL, gifted, special needs, on level, etc.), and teaching philosophies provided aspects of great diversity among MSP participants. The scope and variety of shared experiences provided through the MSP, allowed participants to form strong bonds with one another- despite their differences. Zepeda (2008), states that although adults can learn “on their own,” learning in the company of others is a more powerful design for professional development that supports the adult learner. The MSP community of learners encouraged each other to take risks, share and learn together. Communication among MSP participants wasn’t limited to formal MSP training sessions. Participants reported emailing, meeting in person, attending social events, and other methods of collaboration among one another between sessions. In a focus group one participant shared,

> I can now go outside my school for additional help. I emailed one of the teachers here to ask for help. It was so empowering! I didn’t feel like I am stuck and having to manage other stresses.

This continued collaboration, networking, and support afforded sustainability to the learning
happening during the MSP. The findings of this study support and extend current research on learning communities. Loucks-Horsley et al. (2010) found that the most effective professional developments provided opportunities for teachers to work with colleagues and other experts in learning communities to improve their practice.

The MSP participants were asked to adopt new practices that were in many cases, substantially different from their traditional notions about teaching science. Implementation and adoption of such paradigm shifts in pedagogy do not happen overnight. The sustained nature of the MSP allowed participants the opportunity to discuss challenges they encountered with MSP leaders and participants alike. One participant shared,

One of the things that I think has been the most beneficial has been being able to collaborate and share ideas. We do things in our own school and we kind of get stuck in a rut. Hearing different experiences and ideas or different ways of delivering information helps or letting the children discover has been great.

Participants from other schools shared their experiences with the challenge being discussed. Sometimes they had encountered the same challenge or they shared how they found success. One participant shared how relieved she was to learn that other participants did not like using foldables.

As a new teacher, to be able to collaborate with veteran teachers and being real with one another was valuable. This worked for me or I will try something different next year and not using that politically correct image. For example, doing the foldables was a struggle for me. I was elated to hear that and know it was not just me. I can take it back to the classroom with realistic expectations.

This type of collaboration often included participant experiences when working with children in different settings, (e.g. a Title I school, a class of struggling learners, or a class of predominantly gifted learners), and included pedagogical techniques that were slightly different from the original method illustrated. This was particularly helpful to their peers in similar settings.
However, it was equally valuable for those in different educational settings for the perspective it provided.

**Theme four: Improved Self-Efficacy in Science.** A review of the data revealed that self-efficacy was a noteworthy factor in the transfer of professional learning into classroom practice. Self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura, 1986). MSP participants demonstrated significant improvement in science self-efficacy over the course of their participation in the MSP. Collaboration with peers after attempting to implement new pedagogical strategies to teach challenging content provided participants with the supports necessary to improve their self-efficacy in science. There was not a single element of the design of the MSP professional development that proved to be more effective than others, but rather a combination of the aforementioned themes, that created the conditions necessary to increase participant self-efficacy. This theme will be discussed in greater detail in the subsequent section describing the effects of the MSP on participant self-efficacy.

**Research Question 1b:** What effects did the sustained professional development have on participant self-efficacy as science instructors? Participation in the MSP sustained professional development improved participants’ self-efficacy. Triangulation of data collected support this assertion. A comparison of participant pre and post STEBI scores demonstrated a statistically significant improvement in participant self-efficacy over the course of the MSP. Statistically significant findings indicate that participation in the MSP improved participant self-efficacy as science instructors.

An in depth analysis of STEBI data revealed that the participants demonstrated the highest gains in questions relating to science content and pedagogy. These questions asked
participants to rate their knowledge of the steps necessary to teach science concepts and the availability of necessary skills to teach science (pedagogy). Prior to participating in the MSP one third of participants had a negative or limited perception of their ability to effectively teach science concepts. By the end of the MSP 98% of participants had positive to strongly positive feelings on their ability to teach science concepts effectively. These data combined with participant responses cited earlier, indicate that MSP participants not only understood what they were supposed to be teaching, but that they had learned clear examples of how to apply what they had learned back in their classrooms.

It is likely that the access to materials and resources provided during the MSP contributed to the improved participant self-efficacy with respect to science pedagogy. Participant gains regarding their perceived science teaching skills (pedagogy) increased significantly over the course of the study. On the STEBI posttest, 87% of participants, up from just 30% on the pretest, felt they had the skills necessary to effectively teach science. As reported in chapter four, study data revealed that 90% of study participants were observed using resources and materials supplied during the grant in their classrooms. The access to the necessary materials and resources likely removed a barrier to the implementation of the new strategies learned. These findings when combined with the STEBI data can be used to infer that access to the materials and resources contributed increasing participant self-efficacy in science pedagogy. Teachers had the tools necessary to effectively implement best-practice hands on science learning in their classrooms. The absence of access to the materials and resources would have impacted the ability of participants to practice and refine their science pedagogy.

Participation in the MSP also improved participant self-efficacy with respect to increasing student motivation to learn science. An in depth review of the STEBI data found that
94% of participants, compared to 30% on the pre-test, indicated that they felt confident in their ability to turn students on to science. It can be inferred that participation in the MSP provided participants with a model of how to motivate and inspire students to enjoy science, because that is what it accomplished for them as participants. For example, one participant shared that the MSP has

…made me a better teacher. I’m more enthusiastic and excited about teaching science now that I’ve had this experience and being exposed to different teaching and people in the cohort. It has very much improved my confidence level.

During the second year of MSP, the instructors observed that MSP participants began bringing in their student journals, work samples, and pictures from their classrooms to share with others. They brought artifacts and pictures of trips they took that aligned with concepts being studied. Participants reported going back to their classrooms and modeling lessons with their students, just as they had done them in the MSP. They worked to incorporate the peer collaboration, in their classrooms, whenever possible. One participant reported that her students would rather have science time than go to recess. Viewing these findings through a motivational lens, support Bandura’s assertions on motivation and self-efficacy. MSP participants learned behaviors that they value and believe will have desirable consequences (Bandura, 1986), so they implemented these in their classrooms.

This study found that providing teachers with the opportunity to become part of a community of learners engaging in a sustained professional development was essential to the transfer of learning to the classroom. Of equal importance to the transfer of learning to the classroom, was the design of the MSP sessions, which married content with pedagogy and access to materials. These three elements, content with pedagogy, access to materials, and inclusion in
a community of learners collectively contributed to an increase in participant self-efficacy in science instruction.

**Recommendations**

First, the providers of professional development should ensure that science content and pedagogical knowledge is strengthened simultaneously over time. One recommendation is for providers of science professional development to ensure that they happen sustained period of time. Professional development leaders that the one or two day “silver-bullet” approaches to professional learning do not result in sustained changes in instructional practices. This study demonstrated that significant time, two years in this study, is needed to observe the transfer of learning into classroom practice. This study did not seek to determine the exact amount of time necessary for the transfer to occur, rather it confirmed that the sustained model of professional learning is effective in improving the quality of elementary science instruction.

The second recommendation is for providers of science professional development to model best practice science pedagogy. Professional developers should avoid “do as I say, not as I do” practices. Elementary teachers need to see and participate in effective models of science instruction. Discussion and articulation of the pedagogical practices shared should be explicit and purposeful. Such instruction would allow elementary teachers to experience science instruction through the lens of a student and a teacher. This cast study demonstrates that teachers learn best when they are fully immersed in the learning process, and not merely being told what should be done.

The third recommendation is for providers of science professional development to provide participants with the resources and materials necessary to implement the professional learning in their classrooms. Providing teachers with access to the necessary materials and
resources removes a large barrier to successful classroom implementation of the strategies learned. Whenever possible, select resources and materials that are multi-purpose. This case study found that AIMS lessons, literature connections, and use of the interactive notebook were reported most valuable. These resources are interdisciplinary in nature, affording participants the opportunity to incorporate math and/or literacy skills into their science instruction.

The fourth recommendation is for providers of science professional development to incorporate the opportunity for peer collaboration throughout. Opportunities for collaboration should be frequent and purposeful. Designers cannot hope that collaboration will occur by happenstance. This study found that the careful design of professional learning sessions that allowed participants to collaborate as learners and as teaching professionals alike, produced an effective community of learners. Participant selection was an important component in the success of the peer collaboration experience. Study results hint that random selection of participants, may not produce similar results.

The final recommendation is for providers of science professional development to design experiences aimed at improving participant self-efficacy in science. This study uncovered a correlation between participant self-efficacy and the transfer of professional learning into practice. Teachers with high self-efficacy in science felt better prepared to instruct and motivate their students to learn science. They are also better prepared to withstand setbacks or implementation dips that frequently accompany application of new instructional methods. Monitoring the self-efficacy of participants over the course of a professional development will provide leaders with additional data to monitor the success of the professional learning initiative.
Limitations and Delimitations

As with any study, there are limitations in the findings of this study. Two limitations exist regarding the participants in this study; their small number and lack of diversity. Gall et al. (2007) suggested that to allow for replication, a researcher should select a large sample in order to provide a representation of the population. On the other hand, Yin (2009) stated the sample size does not matter, but what is important is to be able to test a theory. A total of forty-nine participants were used in this case study. While this is a small number compared to all research, it is a large number considering the nature of qualitative case studies. Creswell (2007) asserts the participants should reflect the demographics of the context in which the study takes place. This study’s participants did cross different educational settings from Title I schools to schools with high percentages of English language learners to affluent schools with low percentages of students with free or reduced lunch.

Another limitation of the study was in the participant selection process. Participants were purposefully selected from a pool of applicants based on five criteria. These criteria were (1) years teaching, (2) employed at a high needs school, (3) limited experience teaching science, (4) the rationale they provided when they applied to participate, and (5) administrator recommendation. Neither gender nor ethnicity was considered during the purposeful select of participants. Future studies could select subgroups which reflect their demographics, including more participants and a greater focus on diversity.

One could point out that all participants were selected from teachers who applied to be part of the MSP. The fact that all of the participants applied to be part of a two year science professional development further limits the generalizability of the findings. One could argue that the participants were intrinsically motivated to improve their science instructional practice.
The most obvious limitation was that participants selected to participate in this study were from eight northwest Georgia school systems. Would results be generalizable to schools in other areas of the country? Gall et al. (2007) suggested complete details from thick descriptions in case studies and other qualitative research improve generalizability to different situations, contexts, and people. This case study was filled with thick descriptions, from the words of the teachers, to the description of MSP procedures, to diagrams visualizing the analysis of data. Countless details were provided straight from the experiences of the teachers so thick description can allow for the transfer of this research to schools all over the country.

Delimitation for this study was the use of an outside evaluator to conduct classroom observations. This decision was purposeful and based on a data collected during a pilot study conducted by the researcher. Although the outside evaluator worked diligently to capture the information during the observations and focus groups; Schwant (2007) and Onwuegbuzie, Leech, and Collins (2008) posited that it is difficult, if even possible, to adequately describe a lived happening. The collaboration and debriefing between the outside evaluator and the researcher, as well as the use thick descriptions (Marshall & Rossman, 2006), provided the researcher with a very detailed view into the observations and focus group sessions.

Another boundary for this study was the decision of the researcher to did not analyze or report the elements of the MSP that were ineffective. The focus of this study was on the components of the professional development that enabled and supported the transfer of learning into classroom practice. The researcher decided to maintain a narrow focus to identify the successful components, and not conduct a broad investigation of professional learning in general. This focus on efficacious elements is a common approach in educational research, (Marzano,
The data on the ineffective elements of the professional development were not analyzed by the researcher for these reasons.

**Implications for Future Research**

The most critical implication for future research is science research conducted with practicing elementary teachers as the participants. A review of the literature found an alarming lack of studies focusing on the needs of in-service elementary science teachers. Most studies focused on the needs of middle and high school teachers of science or pre-service teachers. Future studies including more extensive classroom observations of a similar population of teachers could provide a more comprehensive look into elementary science instruction. A better understanding of the factors affecting the complex process of providing quality science instruction at the elementary level is critical for the field.

Future research needs to provide additional exploration of the themes identified in this case study concerning access to materials, resources, and peer collaboration as it related to increased self-efficacy in science. The current economic status has caused professional learning funds to shrink. Administrators and professional learning leaders are tasked with providing the same level of professional learning with less. It is critical that these limited funds are used to purchase materials and resources that have been proven to be effective in multiple settings and configurations. This study just scratched the surface on the benefits of peer collaboration to improve teacher science self-efficacy and the transfer of science professional learning into practice. Subsequent studies on this phenomenon, in the context of elementary science, would provide valuable insights to designers of professional learning experiences.
REFERENCES


Academic Press.


APPENDIX A

COBB COUNTY SCHOOL DISTRICT IRB APPROVAL
APPENDIX A: COBB COUNTY SCHOOL DISTRICT IRB APPROVAL

April 20, 2010

Ms. Sally Creel  
31 Spring Ridge Road  
Kingston, GA 30245  

Dear Ms. Creel:

Your research project has been approved. Listed below are the schools where approval to conduct the research is complete. Please work with the school administrator to schedule administration of instruments or conduct interviews.

<table>
<thead>
<tr>
<th>Elementary School</th>
<th>Elementary School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker Elementary School</td>
<td>Belmont Hills Elementary School</td>
</tr>
<tr>
<td>Blackwell Elementary School</td>
<td>Bryant Elementary School</td>
</tr>
<tr>
<td>Clarkdale Elementary School</td>
<td>Eastvalley Elementary School</td>
</tr>
<tr>
<td>Garrison Mill Elementary</td>
<td>Hayes Intermediate School</td>
</tr>
<tr>
<td>Mableton Elementary School</td>
<td>Mountain View Elementary School</td>
</tr>
<tr>
<td>Mt. Bethel Elementary School</td>
<td>Murdock Elementary School</td>
</tr>
<tr>
<td>Nickajack Elementary School</td>
<td>Norton Park Elementary School</td>
</tr>
<tr>
<td>Pitner Elementary School</td>
<td>Powder Springs Elementary School</td>
</tr>
</tbody>
</table>

Should modifications or changes in research procedures become necessary during the research project, changes must be submitted in writing to the Office of Accountability and Research prior to implementation. At the conclusion of your research project, you are expected to submit a copy of your results to this office. Results cannot reference the Cobb County School District or any District schools or departments.

Research files are not considered complete until results are received. If you have any questions regarding the process, contact our office at 770-426-3407.

Sincerely,

Dr. Judith A. Jones  
Chief Accountability and Research Officer

BOARD OF EDUCATION: Allison Bartlett, Chair • Scott Sweeney, Vice Chair  
Lynda Eagle • Timothy Shultz • David Morgan • Kathleen Angelucci • David Banks

SUPERINTENDENT: Michael Himonas, EdD
APPENDIX B

KENNESAW STATE UNIVERSITY IRB WAIVER
APPENDIX B: KENNESAW STATE UNIVERSITY IRB WAIVER

From: nprange@kennesaw.edu on behalf of irb@kennesaw.edu
To: Sally Creel
Cc: David Rosengrant (drosengr@kennesaw.edu), drmlwarner@gmail.com
Subject: Re: Question regarding IRB
Date: Monday, October 29, 2012 2:30:42 PM

If the existing data will be supplied to you without any information from which you can re-identify research participants, or if the data was coded and you will not have access to the key to decode the data, then you would not be consider to be engaged in human subject research and would not need IRB approval to review this data.

Paula Strange, CIM
Institutional Review Board Administrator
Office of Research | 678.797.2268
http://www.kennesaw.edu/irb/

From: "Sally Creel" <SALLY.CREEL@cobbk12.org>
To: irb@kennesaw.edu
Cc: "David Rosengrant (drosengr@kennesaw.edu)" <drosengr@kennesaw.edu>, drmlwarner@gmail.com
Sent: Monday, October 29, 2012 2:11:06 PM
Subject: Question regarding IRB

Dear IRB Committee Representative,

I am a doctoral student in the Bagwell College of Education. I'm also a cohort leader in the KSU federal MSP grant, of which Dr. David Rosengrant is the PI. The chair of my committee is Dr. Mark Warner. I have gone through the IRB approval process with Cobb County School District regarding my study. My study has been approved. My study is on the MSP and its impact on the participants. I would like access to data that has already been collected as part of the MSP Grant evaluation process. The data were collected by an outside grant evaluator. And will become part of the published over all grant evaluation due to the GA DOE & Federal government. The data will be provided without any participant identifying information. Dr. Rosengrant suggested that I confirm, that I may have access to this data. Please advise.

Kind Regards,
Sally Creel

Sally Creel
Science Supervisor
Cobb County Schools
544 Glover Street
Marietta, GA 30060
770-426-4502

Check out the Elementary Science BLOG at www.cicobb.typepad.com/es

"We must teach students of all ages to become critical thinkers and to gain knowledge, not just
APPENDIX C: TEACHER CONSENT FORM

Letter of Invitation

Cobb County Schools
514 Glover Street
Marietta, GA 30060

May 24, 2010

Dear Educator:

You are being invited to participate in a qualitative research study during the Spring Semester, 2010. The study is related to the Math and Science Partnership Grant you participated in from 2007-2009. The study will be conducted under the supervision of grant recipients Dr. Thomas Brown, Dr. Mark Warner, Dr. Brett Creswell, and Sally Creel of Cobb County Schools.

We will be conducting a two month qualitative study investigating how teachers implement the training they received through the Cobb MSP professional development and what impact, if any, the training had on their science instruction. Teachers will be asked to allow the researcher to visit your classroom and observe you teaching science lessons. In addition to the observations, participants will be asked to participate in a pre- and post-observation interview. I am interested in learning how you design and implement science instruction. Your insight has the potential to improve the quality of future professional development opportunities.

Participation in this research study is voluntary. If you elect to participate you will be requested to engage in reflection regarding your practice. Please understand that I will digitally record (audio only) and transcribe all interviews and that all your remarks will be kept confidential. In order to protect your anonymity, your name and any features that could be used to identify you will be removed from all materials. You may withdraw from the research project at anytime if so desired. Although risks associated with participation in this project are unlikely, you may experience anxiety prior to and/or during interviews. To minimize the effects, you will be encouraged to ask any questions before, during, and after participation in the project and may refuse to comment on any interview question that makes you uncomfortable.

I welcome your questions or inquiries anytime during this research study. I may be contacted at Cobb County Schools (770-426-3562) or on my cell (770-547-6489) anytime. A summary of results will be provided to you upon request when it becomes available. Research conducted through Kennesaw State University that involves human participants is carried out under the oversight of an Institutional Review Board. Questions or problems regarding these activities should be addressed to Dr. Ginny Q. Zhan, Chairperson of the Institutional Review Board, Kennesaw State University, 1000 Chastain Road, #2202, Kennesaw, GA 30144-5591, (770) 423-6679.

Yours truly,

Sally Creel, Principal Investigator and Science Supervisor
Curriculum and Instruction
Cobb County Schools
Marietta, GA 30060
Professional Development into Classroom Practice
Consent Form

I, ____________________, agree to give my consent to participate in the research entitled *Elementary Science Teachers Translate Professional Development into Classroom Practice*, which is being conducted by Sally Creel, 770-426-3562. All research is being conducted under the guidance and supervision of Dr. Tom Brown, Dr. Mark Warner, and Dr. Brett Creswell. I understand that this participation is entirely voluntary; I can withdraw my consent at any time and have the results of the participation returned to me, removed from the experimental records, or destroyed.

The following points have been explained to me:

1. The reason for this project is to strengthen science education in Georgia by examining the elements of science professional development that are implemented in the classroom. The primary purpose of the research is to identify the most effective components, practices, and methods from the MSP training to improve the effectiveness of future professional learning opportunities.

2. The procedures are as follows: Participants will be asked to select a minimum of four dates to allow the researcher to observe a science lesson. Prior to each observation, the participant will be asked to participate in a brief interview to discuss the lesson to be observed. Following each observation participants will be asked to participate in a post-observation interview to discuss the instructional decisions made during the lesson. Interviews may be recorded using an audio recording device. Interviews and observational data may be reviewed by supervising professors. All records associated with this study will be destroyed one year following the completion of the study.

3. The risks, discomforts or stresses that may be faced during this research are: There are no anticipated risks or known factors to cause discomfort or stress.

4. The results of this participation will be anonymous [or confidential] and will not be released in any individually identifiable form without the prior consent of the participant unless required by law. Participation in the study is voluntary and will not affect employment status or annual evaluations. If I decide to withdraw permission after the study begins, I will notify the Sally Creel of my decision.

Signature of Investigator  Signature of Participant  Date

PLEASE SIGN BOTH COPIES. KEEP ONE AND RETURN THE OTHER TO THE INVESTIGATOR.

Research at Kennesaw State University that involves human participants is carried out under the oversight of an Institutional Review Board. Questions or problems regarding these activities should be addressed to Dr. Ginny Q. Zhan, Chairperson of the Institutional Review Board, Kennesaw State University, 1000 Chastain Road, #2202, Kennesaw, GA 30144-5591, (770) 423-6679.
APPENDIX D

MSP PARTICIPANT SELECTION APPLICATION
APPENDIX D: MSP PARTICIPANT APPLICATION

MSP Application to Participate 2011

2. Participation Requirements & Benefits

Participant Benefits

• 15 PLUs earned over the grant training cycle.
• A stipend of $800 (plus $125 bonus for attending 9 of the 10 days) paid to each participant for attendance during the summer training.
• Approximately $200 of resources/materials for your classroom.
• Opportunity to attend state/regional science/math conference of your choice.
• Variety of high quality hands-on learning experiences correlated to grade level/course standards.
• In-depth training in science and/or math concepts and understandings.
• Strategies for differentiating learning, products, and assessments in the science and/or math classroom.
• Numerous resources and materials for each participant to use in their classroom.
• Interaction with a community of other highly motivated teachers of the same grade level.
• Access to science/math content specialists for questions, ideas, suggestions, or resources.

Participant Requirements

• Commitment to a TWO year training cycle. Fourteen days year 1 and fourteen days year 2.
• Attendance at 2 week long training sessions over the summer on July 11-16 & 18-22 from 8:00-4:00 daily. Attendance each day is required. A second 2-week PD session over the summer will also be required during year 2. Dates for year two will be decided by participants and instructors.
• 3 days of follow up science and/or math trainings spread out over the school year for years 1 & 2. Fall 2011 dates are Sept. 16th & Nov. 4. Payment for subs will be provided through the grant. Future training dates will be determined by participants.
• Attendance at one day of a state science (GSTA) or math (GCTM) conference of your choice.
• Payment for conference registration and subs will be provided through the grant.
• Desire to learn and improve science and/or math content knowledge and work collaboratively with group members.
• Willingness to implement new strategies, techniques, and report on experiences and results.

1. By checking the box below you are agreeing to the participation requirements listed above.

☐ Yes, I have read the MSP grant participant requirements and I would like to participate.
3. Cohort Selection

1. The MSP Grant will have several different cohorts. Please select the cohort you would like to join.

- 3rd Grade Math & Science
- 7th Grade Life Science
- HS Physical Science
- HS Mathematics
### 4. 3rd Grade Participant Information

1. Please complete the following.

   - **Name:**
   - **Name of School:**
   - **School Email Address:**
   - **Personal Email Address:**
   - **Grade Level/Course Teaching:**
   - **Number of Years Teaching:**
   - **Phone Number:**
   - **Administrator’s Name:**
   - **Administrator’s Email:**

2. Why would you like to participate in this training? What do you hope to gain from this experience?

3. How do you feel about teaching science and/or math currently? What challenges / successes have you experienced while teaching science and/or math content?
MSP Application to Participate 2011

4. Have you previously attended/participated in math and/or science professional development? If so, please describe the professional development opportunities (who conducted the training, what was covered, when, etc.)
APPENDIX E

MSP PARTICIPANT SELECTION RUBRIC
## APPENDIX E: MSP PARTICIPANT SELECTION RUBRIC

<table>
<thead>
<tr>
<th>Criteria</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Needs School</td>
<td>School CRCT scores are in bottom 10% for the district. AND Title I School.</td>
<td>School CRCT scores are in the bottom 25% of the district AND/OR Title I School</td>
<td>School CRCT scores are between 25%-75% of district scores.</td>
<td>School CRCT scores are in the top 75% of district.</td>
</tr>
<tr>
<td>Year Teaching</td>
<td>0-4 years</td>
<td>5-9 years</td>
<td>10-15 years</td>
<td>16+ years</td>
</tr>
<tr>
<td>Admin Recommend</td>
<td>Unsolicited plea from admin for teacher to be part of program.</td>
<td>Admin suggested teacher would be a good candidate</td>
<td>Admin neutral about teacher participating in the program.</td>
<td>No response from admin.</td>
</tr>
<tr>
<td>Why Participate</td>
<td>Response provides limited or no evidence of positive impact on teaching performance and desire to improve.</td>
<td>Response provides some evidence of positive impact on teaching performance.</td>
<td>Response provides clear evidence of positive impact on teaching performance.</td>
<td>Response provides clear and convincing evidence of positive impact on teaching performance.</td>
</tr>
<tr>
<td>View of Science</td>
<td>Response shows a very limited understanding of (or serious misconceptions about) student learning and science education.</td>
<td>Response shows a partial understanding of student learning and science education.</td>
<td>Response shows a solid and less sophisticated understanding of student learning and science education.</td>
<td>Response shows an in-depth sophisticated understanding of student learning and science education.</td>
</tr>
<tr>
<td>Experience</td>
<td>Applicant provides evidence of limited educational experiences and professional activities.</td>
<td>Applicant provides evidence of a some educational experiences and professional activities.</td>
<td>Applicant provides evidence of a variety of educational experiences and professional activities.</td>
<td>Applicant provides evidence of a variety of distinguished educational teaching experiences and professional activities (such as conference presentations, school leadership roles, article submissions, advanced degrees, etc.).</td>
</tr>
</tbody>
</table>
APPENDIX E

SUMMATIVE QUESTIONNAIRE
APPENDIX E: SUMMATIVE QUESTIONNAIRE

KSU Follow Up Questionnaire

We would like to ask you a few questions about your participation in the KSU MSP learning opportunities over the last two weeks. Your responses will be kept confidential. No individual will be identified in any reports, written or oral, generated by the evaluation team.

Please respond to the following items by indicating your agreement or disagreement with the statements provided.

Key: SA Strongly Agree
     A  Agree
     N  Neutral
     D  Disagree
     SD Strongly Disagree

1. I found the learning opportunities to be valuable.
   SA  A  N  D  SD

2. Participating in these learning activities was a good use of my time.
   SA  A  N  D  SD

3. On the average, the persons facilitating these learning opportunities were well prepared.
   SA  A  N  D  SD

4. I had ample time to practice/experiment with the skills/information presented.
   SA  A  N  D  SD

5. I had opportunities to ask questions about the material being presented.
   SA  A  N  D  SD

6. I am already planning to make instructional use of some of the things I learned.
   SA  A  N  D  SD

Now, please respond to the following open ended questions.

7. Please list two things that you learned that you plan to use in your classroom.
8. Did you find any of the information presented unclear? If yes, please briefly describe.

9. We are interested in receiving constructive criticism. How would you suggest that we modify these learning activities to make them a more valuable use of your time?

10. What was the most beneficial aspect for you in this professional development?

11. What was the least beneficial aspect for you in this professional development?

12. What are your thoughts on the Tellus/Nature Center trips (or the Six Flags/Fernbank trips for Physics)?
APPENDIX G

OBSERVATION PROTOCOL
APPENDIX G: OBSERVATION PROTOCOL

1. Name of Observer

2. First and last name of Teacher being observed.

3. Date

4. Name of School

5. Observation Time in Classroom

6. Cohort

7. Subject Content
   a. Math or Science

8. Differentiation, Check all that apply
   a. Instructional differentiation for special needs students
   b. Instructional differentiation for ELs
   c. Assessment strategies specific for special needs students
   d. Assessment strategies specific for ELs
   e. Unable to observe differentiation
   f. Differentiation not required for this class

9. Was the lesson plan provided?

10. Was the lesson plan followed?

11. If no, indicate the deviation and reason for the deviation.

12. Was the connection to the MSP training content evident during the observation of the lesson?

13. Did the MSP training include discussion стратегий for integrating math and science?

14. Were students engaged using a hands-on activity?

15. Additional comments
APPENDIX F

MSP FOCUS GROUP PROTOCOLS FOR YEARS 1 & 2
APPENDIX F: MSP FOCUS GROUP PROTOCOLS FOR YEARS 1 & 2

KSU MSP Focus Group Protocol for Year One (2011-2012) & Year Two (2012-2013)

The participants will be asked to focus on the first year of the program during the first focus group and year two during the second.

The following questions will be asked.

1. What were your expectations when you enrolled in the KSU MSP program?

2. How beneficial has your participation in the MSP program been to you?

3. How have you applied in your classrooms what you have learned through your participation?

4. What has been the most outstanding thing for you during your participation in the program?

5. What changes in the program would you suggest to make the program even more effective in the future?

6. Are there any other comments that you want to make concerning the MSP program?
APPENDIX I

SCIENCE TEACHING EFFICACY BELIEF INSTRUMENT (STEBI)
APPENDIX I: SCIENCE TEACHING EFFICACY BELIEF INSTRUMENT (STEBI)

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

SA = STRONGLY AGREE  
A = AGREE  
UN = UNCERTAIN  
D = DISAGREE  
SD = STRONGLY DISAGREE

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