

**University and Elementary School Perspectives
of Ideal Elementary Science Teacher
Knowledge, Skills, and Dispositions**

by

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Abstract

Teacher education knowledge, skills, and dispositions have recently become a well-discussed topic among education scholars around the nation, mainly due to its attention by the National Council for Accreditation of Teacher Education (NCATE) over the past few years. Accrediting agencies, such as NCATE and the Interstate New Teacher and Assessment and Support Consortium (INTASC), have sought to improve the quality of teacher education programs by examining knowledge, skills, and dispositions as factors in preparing highly-qualified teachers. There is a paucity of research examining these factors for elementary science teachers. Because these factors influence instruction, and students are behind in scientific and mathematical knowledge, elementary science teachers should be studied. Teacher knowledge, skills, and dispositions should be further researched in order to ultimately increase the quality of teachers and teacher education programs. In this particular case, by determining what schools of education and public schools deem important knowledge, skills, and dispositions needed to teach science, higher education institutions and schools can collaborate to further educate these students and foster the necessary qualities needed to teach effectively. The study of knowledge, skills, and dispositions is crucial to nurturing effective teaching within the classroom.

Results from this study demonstrated that there were prominent knowledge, skills, and dispositions identified by teachers, administrators, and science teacher educators as important for effective teaching of elementary science. These characteristics included: a willingness to learn, or open-mindedness; content knowledge; planning, organization, and preparation; significance of

teaching science; and science-related assessment strategies. Interestingly, administrators in the study responded differently than their counterparts in the following areas: their self-evaluation of teacher effectiveness; how the teaching of science is valued; the best approach to science teaching; and planning for science instruction. When asked of their teaching effectiveness while teaching science, principals referred to enjoying science teaching and improving their practice, while teachers and science teacher educators discussed content knowledge. Administrators valued conducting experiments and hands-on science while teaching science, while their educational counterparts valued creating student connections and providing real-life applications to science for students. In their professional opinions, administrators preferred a hands-on approach to science teaching. Teachers and science teacher educators stated that they view scientific inquiry, exploration, and discovery as effective approaches to teaching within their classrooms. Administrators predicted that teachers would state that lack of resources affects their lesson planning in science. However, teachers and science teacher educators asserted that taking time to plan for science instruction was most important.

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CHAPTER ONE

INTRODUCTION

Teacher dispositions have been studied historically by researchers, using related terms such as attitudes, beliefs, values, characteristics, and perceptions (Knopp & Smith, 2005; Smith, Knopp, Skarbek, & Rushton, 2005; Jones & Carter, 2007). The use of these various terms has made it a bit difficult for researchers to locate past studies relating to teacher dispositions (Knopp & Smith, 2005). Katz and Raths (1985) clearly define dispositions and compare and contrast the term with habits, skills, attitudes, and traits. They state, “[A] disposition is defined as an attributed characteristic of a teacher, one that summarizes the trend of a teacher’s actions in particular contexts” (Katz & Raths, 1985, p. 301). They were monumental in being the first to directly suggest that teacher education programs include professional dispositions as goals for teacher candidates (Katz & Raths, 1985). Later, educational organizations focused on the study of teacher knowledge, skills, and dispositions. Accrediting agencies, such as the National Council for Accreditation of Teacher Education (NCATE) and the Interstate New Teacher Assessment and Support Consortium (INTASC), have sought to improve the quality of teacher education programs by examining knowledge, skills, dispositions as factors in preparing highly-qualified teachers (Koeppen & Davison-Jenkins, 2007; Smith et al., 2005; Thornton, 2006).

Teacher education dispositions have recently become a well-discussed topic among education scholars around the nation, mainly due to its attention by NCATE over the past few years (NCATE, 2006). NCATE defines dispositions as “values, commitments, and professional ethics that influence behaviors toward students, families, colleagues, and communities and affect

student learning, motivation, and development as well as the educator's own professional growth" (NCATE, 2006, p. 53). In relation to teacher education, dispositions are those characteristics or attributes that are present in the professional educator.

Both NCATE and INTASC provide examples of knowledge, skills, and dispositions that, in their professional opinion, teachers should possess. Compared to INTASC, NCATE provides more of a general overview. According to NCATE (2006):

Dispositions are guided by beliefs and attitudes related to values such as caring, fairness, honesty, responsibility, and social justice. For example, [teachers] might include a belief that all students can learn, a vision of high and challenging standards, or a commitment to a safe and supportive learning environment. (p. 53)

While NCATE (2006; 2008) distinguishes fairness and the belief that all students can learn as the two dispositions necessary for teaching candidates, INTASC (1992) identifies detailed dispositions for institutions to adopt. NCATE states that institutions should also refer to INTASC for desirable dispositions for teachers (2006; 2008).

In 1992, INTASC, comprised of a team of teachers and representatives from various state education agencies, provided ten principles with corresponding knowledge, skills, and dispositions that they believe each teacher should have upon beginning the profession. The principles include: understanding of concepts, inquiry, and discipline; understanding of child development and learning; use of differentiated learning and instruction; understanding and use of various instructional strategies to develop critical thinking, problem solving, and performance skills; individual and group motivation of students; use of verbal, nonverbal, and media communication techniques; use of instructional planning based on content, students, community, and curriculum goals; use of formal and informal assessment strategies; being a reflective

practitioner; and the maintenance of healthy relationships with educational constituents for the sake of the student. INTASC states, “In sum, these standards aim to develop beginning professionals while contributing, at the same time, to the development of the profession” (1992, p. 11). These standards were designed so that teachers would have a common list of knowledge, skills, and dispositions to assist students with gaining the knowledge, skills, and dispositions needed for the 21st century (INTASC, 1992). INTASC (2002) then followed this information with a set of criteria that included knowledge, skills, and dispositions necessary for beginning K-12 science teachers. The criteria includes: content knowledge; student learning and development; student diversity; instructional variety; learning environment; communication; curriculum decisions; assessment; reflective practitioners; and community membership (INTASC, 2002). INTASC’s principles, with NCATE’s support, have laid the foundation for teacher expectations and dispositional qualities in schools.

Rationale for the Study of Teacher Knowledge, Skills, and Dispositions

The study of knowledge, skills, and dispositions is crucial to nurturing effective teaching within the classroom. Despite one’s role in education, one cannot deny that education and learning affects all mankind. Knopp and Smith note (2005):

Parents, children, and students interested in effective learning seek the most effective teachers with the traits that each considers valuable. In education systems locally and nationally, there is an increased emphasis on accountability and the quest to identify teacher effectiveness, as the primary influence on student outcomes has intensified greatly. (p. 1)

Indeed, the quality of teacher effectiveness is being called into question, and the study of dispositions helps further understand why and what can be done. While skills and content knowledge are significant for teachers, it is important to not ignore values and beliefs as well, and how they affect instruction for all children. Knowledge, skills, and dispositions directly influence the delivery of instruction; those characteristics important to teachers can be seen in the way they teach their students (Hammerman, 2006). In Sanders and Rivers' (1996) landmark study of teachers and student achievement, the researchers discovered that as teaching effectiveness increased, student achievement increased as well. Students with the lowest level of achievement were the first to benefit from gains in teaching effectiveness (Sanders & Rivers, 1996). Helm notes, "Proper training and certification, matched with the identification and assessment of proper teacher dispositions, both have a significant impact on student learning" (2007, p.110). In a study of elementary preservice teachers, Giovannelli found that having a reflective disposition positively attributes to effective instruction (2003). The study of dispositions can bring about change by bringing values and beliefs to the forefront, instead of simply knowledge and skills. All are essentially significant. Identifying knowledge, skills, and dispositions from the perception of educators would assist them with setting goals for effectiveness within the science classroom. Katz and Raths (1985) state:

By introducing the construct of dispositions into the discussion of teacher education goals, we hope to alert teacher educators to their potential contribution to strengthening dispositions that are desirable and weakening those that are undesirable, and to the potential error in assuming that observing a given skill on a few occasions is a sufficient criterion of teacher competence. (p. 303)

The study of knowledge, skills, and dispositions, that impact teacher practice, can help to identify weaknesses and strengths in teachers. In teacher education, after weaknesses and strengths are identified, classes and laboratory experiences can be designed to further address those knowledge, skills, and dispositions that are less present. The identification of these attributes, whether strong or weak, can be used to determine professional development and planning for inservice teachers.

Statement of the Problem

The study of knowledge, skills, and dispositions is essential. When teachers possess the necessary attributes for instruction, students are effectively taught the knowledge and skills needed to perform and succeed in today's society. Specifically, studying elementary science teacher knowledge, skills, and dispositions may help to address negative attitudes and beliefs about teaching science, which may assist institutions and schools in creating programs and courses to reduce these modes of thinking. In this current study, the researcher examined the perception of knowledge, skills, and dispositions needed to effectively teach elementary science. These perceptions were studied in one local school system among K-5 administrators, university professors in elementary science education, and practicing elementary teachers who teach science. The following research questions guided this study: (1) What do education stakeholders (professors, principals, and teachers) consider to be the ideal knowledge, skills, and dispositions for effective elementary science teachers and teaching? and (2) what similarities and differences in perceptions exist between these stakeholders?

As a result of this qualitative study, the researcher wishes to utilize the participants' responses to further improve communication, teaching, and support of all those involved in elementary science instruction in this local system. Analyzing educators' responses in regards to

science teacher knowledge, skills, and dispositions will provide an in-depth look into science education as it is valued and practiced in the school by teachers. The findings may indicate what schools and institutions can do together to more effectively prepare tomorrow's science educators. Readers of the study may also further determine whether schools and teacher education institutions are in agreement, or disagreement, concerning what knowledge, skills, and dispositions best describe the ideal elementary science teacher in their systems. Consequently, results of the study will further support the need for collaboration in schools and higher education institutions for teacher education.

Theoretical Framework

The researcher's study is based on a grounded theory approach to research, developed by Barney Glaser and Anselm Strauss in 1967. This approach rests on the belief that theory emerges from the researcher's data (Glaser & Strauss, 1967; Creswell, 2007). Data from documents, such as interviews and field notes, are analyzed sentence by sentence or phrase by phrase (Strauss, 1987). Charmaz states, "Grounded theory entails developing increasingly abstract ideas about research participants' meanings, actions, and worlds and seeking specific data to fill out, refine, and check the emerging conceptual categories" (2005, p. 508). Charmaz's (2005) constructivist grounded theory builds on the ideas of Glaser and Strauss (1967). She asserts:

[W]hat observers see and hear depends upon their prior interpretive frames, biographies, and interests as well as the research context, their relationships with research participants, concrete field experiences, and modes of generating and recording empirical materials. No qualitative method rests on pure induction – the questions we ask of the empirical world frame what we know of it. In short, we share in constructing what we define as data. (Charmaz, 2005, p. 509)

The constructivist view states that there is no right or wrong answer to the question or questions that may be asked by the researcher. This view also allows the researcher to combine critical inquiry with grounded theory using a new and innovative approach (Charmaz, 2005).

This constructivist view can also be transferred over to the case study method, the other qualitative approach that is utilized by the researcher. According to Denzin and Lincoln (2005), constructivism is best for interpretative case studies. Yin (2003) maintains, “As a research strategy, the case study is used in many situations to contribute to our knowledge of individual, group, organizational, social, political, and related phenomena” (p. 1). The researcher is involved in exploration within a bounded system (case) or systems (cases) over time, using various sources of information for data collection (Creswell, 2007). Creswell suggests:

When multiple cases are chosen, a typical format is to provide a detailed description of each case and themes within the case, called a within-case analysis, followed by a thematic analysis across cases, called a cross-case analysis, as well as assertions or an interpretation of the meaning of the case. (2007, p. 75)

The researcher utilizes both the within-case (for one school) and cross-case (for multiple schools) analyses in the study of elementary science teacher dispositions. The researcher then interprets the meaning of the cases studied for the reader (Creswell, 2007).

Research Context and Methods

The dispositions of elementary science teachers require further study, preferably with a qualitative approach. Consequently, most past studies have been limited to those that are quantitative in nature, utilizing semantic differentials and Likert scale instruments (Jones & Carter, 2007). Why would the researcher choose a qualitative approach to conduct a study of

elementary science teacher knowledge, skills, and dispositions? First and foremost, a qualitative approach is appropriate when a certain issue or problem requires more exploration, i.e.

elementary science teacher dispositions (Creswell, 2007). Qualitative studies also allow the researcher to take a more humanistic approach, and stress the importance of the participants' words instead of on numbers (Lichtman, 2006). This study's data consists of words from each educational stakeholder's perspective, artifacts such as lesson plans and syllabi, and the researcher's own researcher journal. The research is conducted using a cross-case study approach for two local schools; the case study approach is used when the researcher wishes to conduct a more in-depth study (Creswell, 2007). Also, Yin notes:

A...common concern about case studies is that they provide little basis for scientific generalization. "How can you generalize from a single case?" is a frequently heard question....The short answer is that case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes. In this sense, the case study, like the experiment, does not represent a "sample," and in doing a case study, your goal will be to expand and generalize theories (statistical generalization). (2003, p. 10)

Although some may argue that the use of the case study of approach cannot be justified, it is the researcher's belief that this method was best-suited for this research study. The researcher does not suggest that the findings be viewed as true of all elementary science teachers, elementary principals, and elementary science education professors. However, she does suggest that these findings be used to guide further research and emerging theories associated with elementary science teacher dispositions.

Role of the Researcher

The researcher acted as the key instrument for the study. She collected data by interviewing participants (principals, teachers, and university professors) and analyzing lesson plans and syllabi submitted by current elementary science teachers and science education professors (respectively). Additionally, Lichtman (2006) states:

Qualitative researchers involve themselves in every aspect of their work. Through their eyes, data are developed and interpreted. Through their eyes, meaning is brought from an amalgam of words, images, and interpretations. Through their eyes, a creative work comes into fruition. (p. 206)

As the key researcher, it is the researcher's wish that she is able to convey and speak for participants, not only through their words, but also through her words as a teacher representative and researcher grounded in the data.

As a former elementary science teacher, the researcher is able to identify with elementary teachers of science. She has taught science in both self-contained and departmentalized elementary classrooms, and therefore understands both classroom settings. According to Lichtman, "All information is filtered through the researcher's eyes and ears. It is influenced by his or her experience, knowledge, skill, and background" (2006, p. 12). Responses from participants may be easier to comprehend, taking into consideration the researcher's previous professional experiences. In addition, being a current graduate student in the higher education setting also allowed the researcher to take a somewhat outside approach to the study as well. Being an outsider is also beneficial in that the participants are most likely to feel comfortable being honest and open with someone who does not share the same environment with them; the

researcher is also less likely to have any bias towards any educational constituent involved, since she is enlisting responses from each participant, using the same questions in each interview.

Overview of Participants

Participants of the study included educators from university and elementary school settings. From the university level, elementary science teacher education faculty was asked to participate. The participants consisted of two science education professors that taught science methods courses at a large southeastern institution. Additionally, education faculty members that participated were selected on the premise that they had previous experience teaching science to preservice and inservice elementary teachers. Elementary teachers of science and elementary administrators were asked to communicate their thoughts on behalf of the elementary school setting. The principals of Jefferson Elementary and Rosebud Elementary, two schools that work closely with the university, were selected. Consequently, these administrators provided a list of all elementary teachers at their respective schools, in grades 3-5, who teach science at least one-half of the semester. For the sake of this study, elementary science teachers are defined as those third through fifth grade teachers that teach science at least half of the semester. (This accounts for those that alternate between teaching science and social studies during the year.) The researcher then solicited these teachers to participate in the study, specifically selecting at least one teacher from each grade level. (Of Rosebud Elementary, one fourth grade and two fifth grade teachers participated. Three third grade teachers, one fourth grade teacher, and one fifth grade teacher participated at Jefferson Elementary.) The third through fifth grade teachers were selected to show diversity across grade levels.

Data Collection

The researcher utilized a focus group interview for teacher participants at each school site, and an individual interview for school administrators and education faculty, to obtain participants' responses. Interviews, or "professional conversations," were conducted face-to-face within the elementary school and institutional setting. A list of guiding interview questions was utilized (Appendices C, D, and E). However, the researcher was not bound to those questions (Schwandt, 2007). More questions were asked based on the participant's response at the time of the interview. Comments made during the focus group interview or individual interviews sometimes caused the researcher to create impromptu questions, which provided an in-depth understanding of the study. These interviews were recorded and transcribed for further data analysis.

The researcher also asked elementary science teachers to submit one lesson plan each that supported their perspective of effective science teaching. These lesson plans were documented as artifacts for the study. Participating faculty members were also asked to submit syllabi for elementary science methods courses. Schwandt (2007) states, "An artifact is an object that carries meaning about the culture of its creators and users. Understanding and interpreting the composition, historical circumstances, function, purpose, and so on of artifacts are central to the study of material culture" (p. 9). The lesson plans and syllabi represented a few of the many types of artifacts that can be used when conducting a case study (Creswell, 2007).

Lastly, data was collected by means of a personal researcher journal kept by the researcher. The researcher wrote in her journal as often as possible and included such data as questions, thoughts, and revelations made during the study. According to Lichtman, "Self reflection is critical in the new qualitative traditions. By keeping a journal, you will be able to

examine your own thinking and motivations and how they influence and are influenced by the work you do” (2006, p. 85). Not only does the journal serve as a document or form of data for the study, but excerpts from the journal may be used to further clarify the researcher’s thought process during the study. Other uses for a researcher journal include: issues that develop regarding research; hypotheses; additional research questions that may evolve; daily reminders; books to read; subjects to contact and/or consult; additional data to be collected, and analytic memos (Holly, Arhar, & Kasten, 2005). The journal was also used for analytic memos and notes of the researcher’s thinking as the study progressed.

Data Analysis

This study followed a cross-case study approach. Creswell (2007) states, “[C]ase study research involves the study of an issue explored through one or more cases within a bounded system (i.e., a setting, a context)” (p. 73). A number of cases were researched as a multi-site study (Creswell, 2007; Lichtman, 2006). Each of these specific categories was studied as cases; each individual elementary school and the university are cases within a bounded system of the university-school teacher education system.

As the researcher received responses from each participant through audiotaped interviewing, she gathered the data, transcribed it, and read it to gain evidence that closely related to the research questions and issues stated (Holly et al., 2005). The researcher aimed to discover patterns in participants’ responses as they related to their dispositions (values and beliefs) in the area of elementary science education. Creswell states, “A case study is a good approach when the inquirer has clearly identifiable cases with boundaries and seeks to provide an in-depth understanding of the cases or a comparison of several cases” (2007, p. 74). Emerging themes were sought through data analysis; data were analyzed through coding (or breaking down

data into categories or themes). These categories were based on the INTASC (2002) science teacher dispositions discussed later in this work, using these dispositions as a guide when comparing and contrasting responses. This process was ongoing as more data was received and reread (Lichtman, 2006; Schwandt, 2007). Similarities and differences were noted within and across cases. Afterwards, assertions and generalizations were then made based on data analysis (Schwandt, 2007). Data were categorized and re-categorized into manageable sections whenever necessary; categories were then assigned with names by the researcher (Lichtman, 2006; Creswell, 2007; Schwandt, 2007).

Research Results

Credibility of Results

Credibility, dependability, and transferability were also addressed. To gain credibility in the study, the researcher attempted to establish a rapport or gain trust with participants. She visited the elementary schools and institution that agreed to participate to become more familiar with the culture being studied (Creswell, 2007). The use of multiple data sources contributed to triangulation of the study (Creswell, 2007; Lincoln & Guba, 1986). Teacher data were triangulated from focus group interviews and the additional lesson plan information, faculty data were triangulated from their individual interviews and syllabi, and principal data were triangulated from their individual interviews and actual support of science-related professional development and programming. Data gathered by the researcher was compared with past research, compared within and across categories, and multiple data sources as mentioned above (i.e., interviews, field notes, and researcher journal) were utilized (Lincoln & Guba, 1986; Creswell, 2007; Schwandt, 2007). Lastly, to allow for transferability, a thick description of the

context of this study and its results are given. The researcher reported the findings of the study so that the reader may choose to apply its results to his/her similar situation (Lincoln & Guba, 1986).

Overview of Results

The researcher found that elementary science teachers, elementary principals, and professors of elementary science methods courses had, for the most part, similar perspectives on those knowledge, skills, and dispositions needed for effective elementary science teachers. The identified knowledge, skills, and dispositions were also aligned with INTASC (2002) standards and associated knowledge, skills, and dispositions for beginning science teachers. Educational stakeholders identified dispositions such as: a willingness to learn; open-mindedness; catering to students' needs; content knowledge; enthusiasm and excitement; planning and organization; preparation; self-confidence; having a positive attitude; patience; flexibility; recognizing the importance of teaching science; being unafraid to teach science; recognizing the need for professional development; and assessment strategies. However, other emerging themes and topics were discovered that related to effective elementary science teaching. These topics included: inquiry; hands-on science; the need for more methods courses and time in the classroom for preservice teachers; course of study and standards; the lack of resources and materials; the learning cycle; the importance of exploration and discovery; and AMSTI (Alabama Math, Science, and Technology Initiative). Interestingly, knowledge, skills, and dispositions and science-related topics were identified within-case, cross-case, and at times, one and/or two categories (teachers, principals, and professors). These findings will be discussed, in further detail, in the upcoming chapters of three and four, after literature of dispositions and their

application to elementary science education are reviewed in chapter two. Lastly, the researcher will discuss the conclusions of the study in the culminating chapter five.

Limitations of Study

As with any research study, certain limitations apply. Although the researcher is using a multi-site approach, she may not receive a true representation of all elementary administrators, inservice teachers, and teacher education professors. This study can be used by the reader to apply in their specific classroom or school setting. Due to the qualitative and constructivist nature of the study, readers are less likely to generalize the study findings, as one would in a quantitative study.

Significance of the Study

Why should teacher knowledge, skills, and dispositions be studied? Beginning in the 1990s, teacher education programs and teachers themselves started to be questioned in terms of their quality (Clark, 2005). This quality is affected by a number of influences. Jones and Carter (2007) present a perfect example:

When Janice, a biology teacher, enters the classroom each day, her beliefs and attitudes about science, science learning, and science teaching influence virtually every aspect of her job, including lesson planning; teaching; assessment; interactions with peers, parents, and students; as well as her professional development and the ways she will implement reform. Although this influence is not necessarily linear or obvious, attitudes and beliefs play significant roles in shaping teachers' instructional practices. (p. 1067)

Therefore, teacher knowledge, skills, and dispositions should be further researched in order to ultimately increase the quality of teachers and teacher education programs. In this particular case, by determining what schools of education and public schools deem are the significant attitudes and characteristics needed to teach, higher education institutions and schools can collaborate to further educate these students and foster the necessary knowledge, skills, and dispositions needed to teach effectively.

However, the reader is reminded that the significance of the study may be limited for various reasons. First, each elementary school had only one principal, and therefore was represented by one person in terms of perspectives of administrators (instead of an assistant principal as well). Secondly, the actual teaching practice of instructors was not observed, and not all of the teacher participants attended the institution included in the study. These issues directly influence the reader's opinion of the significance of this study.

Results of this study call for an increased amount of collaboration among elementary schools and institutions of higher learning in the area of fostering positive dispositions for preservice and current teachers in elementary science education. The data collected and analyzed identify discrepancies and/or similarities between elementary schools and teacher education programs relating to the perspectives of desired knowledge, skills, and dispositions for science teachers. Again, these data will set the stage for future planning in methods courses, professional development, and in collaboration between schools and higher education institutions.

Additionally, there had been a need for more research in regard to knowledge, skills, and dispositions of elementary science teachers. More specifically, there is a need for more qualitative research in this area on specific programs and collaborating institutions across K-16. Qualitative studies of dispositions will provide a more human approach; readers will be able to

hear the voice of teachers, K-5 administrators, and university education faculty in local school systems in more detail. This particular study aims to close gaps in these areas of research and lead to implications for further research in elementary science education.

CHAPTER TWO
ELEMENTARY SCIENCE TEACHER
KNOWLEDGE, SKILLS, AND DISPOSITIONS,
AND EFFECTIVE INSTRUCTION

Introduction

The discussion of dispositions has increasingly become integral in determining an educator or future educator's effectiveness within the classroom. The National Council for Accreditation of Teacher Education (NCATE) and the Interstate New Teacher Assessment and Support Consortium (INTASC) are organizations that have provided knowledge, skills, and dispositions for those entering the field of education (Smith, Knopp, Skarbek, & Rushton, 2005; Thornton, 2006; Koeppen & Davison-Jenkins, 2007). NCATE wishes to hold educational institutions accountable for providing high-quality education for all learners. Therefore, this list of knowledge, skills, and dispositions as standards were provided so that higher education institutions can assess or determine if teacher education students are qualified to teach K-12 students effectively. In addition to these accrediting agencies, a number of studies have been conducted to identify the general knowledge, skills, and dispositions of inservice and preservice teachers to include in teacher education programs (Mullin, 2003; Hillman et al, 2006; Johnson & Reiman, 2007).

The aforementioned accrediting agencies, NCATE and INTASC, have created lists of knowledge, skills, and dispositions that teachers should prescribe to in order to deem themselves

effective. NCATE (2008) created their standards, including dispositions, to hold teachers accountable, as well as improve their teaching practice. These standards are reviewed and revised every seven years to guarantee that they remain current and up-to-date. By providing these standards to and for accredited institutions, “NCATE ensures that accredited institutions remain current, relevant, and productive, and that graduates of these institutions are able to have a positive impact on P–12 student learning” (NCATE, 2008, p. 1). NCATE identifies fairness and the belief that all students can learn as the two dispositions necessary for teaching candidates (2006; 2008). INTASC’s list of knowledge, skills, and dispositions is more dated, but still remains relevant to educational entities (1992). Committee members, consisting of educators and representatives from state education agencies, designed a basis for professional teaching standards. These standards, that also include dispositions, should be utilized to improve teacher education programs as they prepare students for the teaching profession. The standards, with related knowledge, skills, and dispositions, include: understanding of concepts, inquiry, and discipline; understanding of child development and learning; use of differentiated learning and instruction; understanding and use of various instructional strategies to develop critical thinking, problem-solving, and performance skills; individual and group motivation of students; use of verbal, nonverbal, and media communication techniques; use of instructional planning based on content, students, community, and curriculum goals; use of formal and informal assessment strategies; being a reflective practitioner; and the maintenance of healthy relationships with educational constituents for the sake of the student (INTASC, 1992).

An early seminal study that also informs this dissertation study’s approach is Cattell’s (1931) quantitative study, in which he asked participants to identify the ten most important traits for veteran and new teachers, and also asked respondents to provide traits that differed for male

and female teachers. Responses were obtained from directors of education, school inspectors, college faculty, elementary and secondary teachers and assistant teachers, preservice teachers, and students in high schools. In this study, Cattell (1931) identified the following responses as significant dispositions for teachers, in order of importance: personality and willpower; intelligence; sympathy and tact; open-mindedness; a sense of humor; idealism; general culture; kindness; enthusiasm; knowledge of psychology and pedagogy; classroom technique; perseverance and industry; self-control; enterprise; orderliness; knowledge of subjects; outside interests; physical health; presence; social fitness; and an alert mind.

Like Cattell's (1931) approach, this study focuses on the perception of necessary teacher knowledge, skills, and dispositions from the perspective of various educational constituents. However, this study also focuses on those dispositions perceived important for K-5 science educators at one research university and its select partner schools. Participants included current elementary science teachers, K-5 administrators, and university science education faculty as case study participants. This study also utilized qualitative research methods, and its results may serve to more effectively science education for elementary preservice teachers and inservice teachers through collaboration between schools and institutions of higher education.

Mullin (2003) chose to assess preservice teachers using a qualitative approach. His study consisted of interviewing participants for approximately an hour. Through the interview process, students were found to have the following characteristics: being prepared; communicating effectively; having a passion for learning; an appreciation towards diversity; having a helping relationship with students; using creativity and being a problem-solver; engaging in positive social interactions; being reflective and open to self-improvement; being a student advocate; fostering positive growth in others; and being intrinsically motivated. The interview assessment

proved effective and helped delineate a teacher education program with dispositions of preservice teachers, so that education faculty knew what skills and content knowledge needed to be taught during courses.

In another study (Hillman et al., 2006), education faculty members created a list of dispositions that they deemed necessary for effective teachers. These categories were: responsibility for learning; interpersonal skills; professionalism; effective use of time and resources; communication skills; higher level thinking skills; and collaborative skills. Before the data were analyzed quantitatively, preservice teachers, identified generally as education majors, were asked to respond whether they *always*, *usually*, or *seldom* demonstrate a particular disposition. Again, the faculty used the information to assess and develop dispositions within their students.

Johnson & Reiman (2007) chose both a quantitative and qualitative approach. Unlike the aforementioned studies, the researchers chose to focus solely on beginning inservice teachers (of various grade levels), instead of preservice teachers. Researchers used a multiple-choice test to determine moral and ethical judgment in teachers. Additionally, interviews were conducted after observing each teacher within the classroom. This study found that when teacher participants made decisions morally, instead of relying on their own personal interests or biases, there was more direct instruction. More time was allotted for inquiry-based learning, considering students' ideas, and providing feedback to students, rather than spending time giving directions and information. This study suggests that teachers' positive dispositional qualities can effectively influence the delivery of instruction.

Elementary Science Teacher Dispositions

The study of science teacher dispositions, in particular elementary science teachers, is fairly new to research. While there are few studies that directly discuss science teacher *dispositions*, there are some that address science teacher attitudes or beliefs. There are also studies that address other factors that contribute to elementary science teacher dispositions: pedagogical content knowledge, self-efficacy, and teacher confidence in science.

Attitudes and Beliefs

The attitudes and beliefs of science teachers can directly influence their dispositional qualities and all aspects of the teaching profession (Jones & Carter, 2007). In providing a definition for teacher attitudes, Koballa (2008) states, “Attitude is commonly defined as a predisposition to respond positively or negatively toward things, people, places, events, and ideas” (Attitude section, para 1). However, previous researchers found that a lack of a solid definition of attitudes and beliefs has become quite complicated for those attempting to review literature pertaining to the two constructs (Knopp & Smith, 2005; Koballa, 2008). According to Czerniak, Lumpe, and Haney, “Teachers’ beliefs can be described as their convictions, philosophy, tenants, or opinions about teaching and learning (1998, p. 125).” Although Czerniak et al. (1998) provide a concrete definition for teacher beliefs, Eisenhart, Shrum, Harding, and Cuthbert (1988) note that education researchers have not come to a general consensus on a single definition of the term belief. Because belief systems have been studied in various fields, the outcome has been an assortment of meanings. (Eisenhart et al., 1988; Pajares, 1992).

A number of studies have focused solely on science attitudes and beliefs relating to elementary preservice teachers. Tosun (2000) wanted to find out the impact of requiring elementary preservice teachers to take science methods courses, especially after already having

negative experiences and outcomes with previous science-related courses. Using an interview method approach, Tosun (2000) found that most elementary preservice teachers overwhelmingly responded negatively towards science instruction, which consequently affected their self-efficacy and confidence in relation to science teaching.

Thomas and Pedersen (2003) sought to examine the self-perception of elementary preservice teachers as science instructors. The researchers hypothesized that students' prior science experiences influenced preservice teachers' view on the nature of science as well as science teaching methods. Results from the study found, "Comments and reflections of preservice teachers indicated that their ideas about science teaching were highly correlated with specific, intense memories of their own science learning experiences in elementary, high school, and college science courses" (Thomas & Pedersen, 2003, p. 326). The researchers suggest that science content and method courses could contribute to positive attitudes and beliefs towards teaching science.

Palmer (2002), on the other hand, studied elementary preservice teachers' attitudes towards science instruction that had changed from negative to positive after being enrolled in a science education course for one semester. He sought to discover the course contents that were responsible for the positive change. Palmer (2002) found that a number of course attributes were responsible for the elementary preservice teachers' change in attitudes, including: the tutor's enthusiastic attitude towards the subject of science; the opportunity to ask questions when needed; and the ability to apply what was learned in the course to theoretical terminology.

In another study, Minger and Simpson (2006) distributed the Revised Science Attitude Scale to students at the beginning and end of an activity-based science course required for all elementary preservice teachers. Overall, the course positively changed elementary preservice

teachers' attitudes towards science instruction. However, there was a small negative shift in relation to the preservice teachers' looking forward to teaching science in the elementary classroom (Minger & Simpson, 2006).

Plourde (2002) examined the affect of student teaching on elementary preservice teachers' self-efficacy and attitudes towards teaching science in the future. The researcher interviewed and observed selected six individuals from three cohort groups. Participants' previous experiences did not adequately prepare students to effectively teach science in the elementary classroom. The researcher found that, for those that attended public schools growing up, science experiences were limited to lectures, textbook reading, and answering questions at the end of chapters in those textbooks. The preservice teachers' internships did not alter students' science teaching beliefs (Plourde, 2002).

Lastly, one particular study, sought to discover the influence a two-year science professional development course had on primary teachers' attitudes, confidence levels, and understanding of science, as well as the effect it had on their students (Jarvis & Pell, 2004). The teachers were asked to complete a confidence and attitude questionnaire and a cognitive test, questioning their knowledge of science content. After being enrolled in the course, the researchers discovered that primary teachers' attitudes and confidence level increased after being enrolled in a two-year science professional development course. Although students' overall mean cognitive score increased, their cognition and attitudes varied by the type of teacher they had. These teachers were identified as: disaffected teachers; those with limited cognitive development; teachers identified as being enthusiastically fired; and unaffected professionals (Jarvis & Pell, 2004).

Pedagogical Content Knowledge

Pedagogical content knowledge can be defined as having knowledge in the content area itself (science) and the ability to use that knowledge to effectively teach for student understanding (Shulman, 1986; Shulman, 1987). In regards to pedagogical content knowledge, participation and enrollment in science methods courses contribute to the effectiveness of science teaching and in preservice teachers' attitude towards science (Minger & Simpson, 2006; Yilmaz-Tuzun, 2008). Bleicher (2006) also found that science methods courses contributed to an increase in pedagogical content knowledge for elementary preservice teachers, specifically those with limited prior knowledge in science. Professional development courses for elementary inservice teachers, taken over an extended period of time (unlike preservice teachers), and designed to increase teachers' cognitive and teachers skills, also help to contribute to an increasing pedagogical content knowledge in science (Jarvis & Pell, 2004; Klein, 2005). Specifically, Trundle, Atwood, and Christopher (2006) discovered that after receiving instruction on the moon's phases, elementary preservice teachers' misconceptions decreased, while their subject knowledge increased. Mulholland and Wallace (2005) found that general teaching knowledge, interactive knowledge (knowledge of self and learners), and science pedagogical content knowledge combined – from the time as a preservice teacher through time as an established teacher – all work to contribute to solid science pedagogical content knowledge.

Self-Efficacy and Teacher Confidence

Lastly, self-efficacy and teacher confidence can also contribute to effective science teaching (Jones & Carter, 2007). Self efficacy can be defined as “one's ability to successfully implement an instructional strategy” (Jones & Carter, 2007, p. 1075). The improvement or enhancement of self-efficacy can improve science instruction for teachers and also positively

affect their attitude towards the teaching of science (Mulholland & Wallace, 2001; Richardson & Liang, 2008). Bleicher's (2006) study found that preservice teachers' self-efficacy and self-confidence in science were increased after taking an undergraduate elementary science methods course. The following studies further indicate that preservice teachers are unprepared to teach science effectively (Jarrett, 1999; Rice & Roychoudhury, 2003). This lack of preparation has also been tied to a lack of confidence in teaching science (Howes, 2002; Jones & Carter, 2007). Rice and Roychoudhury (2003) implemented a study to improve the effectiveness of one of the researchers' science method courses. Specifically, the researchers were able to identify, based on the behaviors of preservice teachers, factors to improve their confidence in science teaching, including "knowing how" to teach science and teaching science "in a different light" (Rice & Roychoudhury, 2003, p. 120). They recognized the importance of teacher confidence in effective instruction. Jarrett's (1999) study looked at the effect of past educational experiences on preservice teachers' confidence in teaching science. The researcher discovered that positive elementary and collegiate experiences in science helped to improve preservice teachers' confidence in science instruction.

Together, these factors (science teacher attitudes and beliefs, pedagogical content knowledge, and self-efficacy and teacher confidence), can contribute to science teachers' knowledge, skills, and dispositions, and tie into INTASC's standards for beginning science teachers (see Table 1). While effective teachers are expected to have certain attitudes and characteristics, such as those previously mentioned, effective science teachers should also possess additional dispositional qualities. Agencies and organizations alike identify knowledge, skills, and dispositions for effective science instructors. The National Science Education Standards state that effective science teachers must have a positive perception of science and

must understand and have a relationship with their students (National Academy of Sciences, 2008). The National Science Teachers Association (NSTA), in agreement with the National Science Education Standards, further state that teachers should continually assess their students, as well as themselves, to allow for optimal scientific learning. Additionally, educators must believe that all children can learn science and involve them in inquiry-based learning (NSTA, 2003).

Science Inquiry in Teaching

According to The National Academy of Sciences (2000), inquiry involves students' ability to design and conduct scientific investigations, as well as their understanding of the nature of scientific inquiry. Inquiry also refers to the strategies that children learn and are taught, that help them master scientific concepts through investigations. The classroom must have a number of characteristics in order for it to be inquiry-based. Therefore, students are engaged in scientific inquiry when they: Ask questions about objects and events in their environment; conduct simple investigations; use appropriate tools and techniques to gather and interpret their data; use evidence found and scientific knowledge to develop explanations; and communicate those investigations, explanations, and data to other students, teachers, and family members (National Research Council, 1996). The National Academy of Sciences (2000) also states that a classroom must have the following essential features in order to be inquiry-based:

Learners are engaged by scientifically oriented questions; learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions; learners formulate explanations from evidence to

address scientifically oriented questions; learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding; learners communicate and justify their proposed explanations.

Assessment is also a significant component of inquiry (National Academy of Sciences, 2000). Assessment is ongoing, and should be conducted at the beginning of each lesson (diagnostic), during each lesson (formative), and at the end of each lesson (summative). A variety of assessment forms should be utilized: formal assessments such as paper and pencil tests, and informal assessments such as observations, rubrics, and checklists (Carin, Bass, & Contant, 2005).

Compared to inquiry, many forms of science learning involve students performing specific, teacher-directed tasks. Teachers use step-by-step procedures without valid explanations for each step. Questions are often left unclear. Lastly, hands-on activities usually terminate students' explorations prematurely and student tasks often become mechanical (Huber & Moore, 2001; Bransford & Donovan, 2005).

In comparison, inquiry is beneficial to students in a number of ways. First, with an inquiry-based approach, students can learn from their own individual experiences and cultures; the real world is brought into their classrooms and lives. It also accommodates various learning styles, and fosters collaboration and teamwork. Inquiry prompts students to utilize problem-solving skills and process skills (i.e., critical thinking and organization of information). Teachers will also observe evidence of children's grasp of new knowledge; these concepts are seen throughout the activity or lesson (Bransford & Donovan, 2005). In addition, science inquiry in instruction will not only benefit students, but will also foster improved self-efficacy in teachers;

teachers with a full understanding of inquiry-based instruction will practice it in their classrooms, and will simultaneously build their self-confidence in teaching (Richardson & Liang, 2008).

The INTASC Standards specifically identify criteria and knowledge, skills, and dispositions for beginning science teachers. A few of these standards include being open to student diversity, possessing science content knowledge, using a variety of instructional strategies, and becoming a reflective practitioner (see Table 1) (INTASC, 2002). Specifically, to meet the goals of this study, the knowledge, skills, and dispositions will be narrowed further to discuss those attributes related to elementary science educators. In order to discuss knowledge, skills, and dispositions, research on the effectiveness of science teaching should also be addressed.

Table 1

INTASC Model Standards for Beginning Science Teachers

Principle	Related Knowledge, Skills, and Dispositions
Content	The teacher of science understands the central ideas, tools of inquiry, applications, structure of science and of the science disciplines he or she teaches and can create learning activities that make these aspects of content meaningful to students.
Student Learning and Development	The teacher of science understands how students learn and develop and can provide learning opportunities that support students' intellectual, social, and personal development.
Student Diversity	The teacher of science understands how students differ in their approaches to learning and creates instructional opportunities that are adapted to diverse learners.
Instructional Variety	The teacher of science understands and uses a variety of instructional strategies to encourage students' development of critical thinking, problem solving, and performance skills.
Learning Environment	The teacher of science uses an understanding of individual and group motivation and behavior to create a learning environment that encourages positive social interaction, active engagement in learning, and self-motivation.

Principle	Related Knowledge, Skills, and Dispositions
Communication	The teacher of science uses knowledge of effective verbal, nonverbal and media communication techniques to foster active inquiry, collaboration, and supportive interaction in the classroom.
Curriculum Decisions	The teacher of science plans instruction based upon knowledge of subject matter, students, the community, and curriculum goals.
Assessment	The teacher of science understands and uses formal and informal assessment strategies to evaluate and ensure the continuous intellectual, social and physical development of the student.
Reflective Practitioners	The teacher of science is a reflective practitioner who continually evaluates the effects of his/her choices and actions on others (students, parents, and other professionals in the learning community) and who actively seeks out opportunities to grow professionally.
Community Membership	The teacher of science fosters relationships with school colleagues, parents, and agencies in the larger community to support students' learning and well being.

Effective Science Teaching Practice

In science education, student achievement in the United States has been found to be below other similar, industrialized countries in the world. According to Miller and Davison (2006), “[T]he United States has fallen behind other countries in the effectiveness of science and mathematics instruction” (p. 56). This presents a problem for the nation’s children. In 2000, the current U.S. Secretary of Education appointed and entrusted twenty-five members in examining the nation’s current state in science and mathematics instruction. The members included various educational constituents (teachers, superintendents, professors, legislators, and state agency representatives). Glenn (2000) stated:

Four important and enduring reasons underscore the need for our children to achieve competency in mathematics and science: (1) the rapid pace of change in both the increasingly interdependent global economy and in the American workplace demands widespread mathematics- and science-related knowledge and abilities; (2) our citizens need both mathematics and science for their everyday decision-making; (3) mathematics and science are inextricably linked to the nation’s security interests; and (4) the deeper, intrinsic value of mathematical and scientific knowledge shapes and defines our common life, history, and culture. Mathematics and science are primary sources of lifelong learning and the progress of our civilization. (p. 7)

The commission members discovered that students are not being adequately taught in science and mathematics, and therefore, do not approvingly compare to their peers in other countries. For these reasons, it is crucial that the effectiveness of science teaching is continuously addressed. Although teacher effectiveness in science instruction has been studied, there must be added attention to elementary science instruction. An issue contributing to the lack of effectiveness in

elementary science teaching is teachers' avoidance of teaching the subject (Appleton, 2007). Other issues include: limited resources and time; low confidence in teaching science; lack of content knowledge; and teachers' perceptions of themselves as learners (Appleton, 2007; Howes, 2002; Jarrett, 1999; Jones & Carter, 2007; Miller & Davison, 2006). Consequently, all of the previously mentioned issues can contribute directly and indirectly to teachers' dispositions in the area of science.

According to Vasquez (2008), effective science teachers participate in professional development; use cooperative learning strategies; test students at least once a month with short-answer or essay questions; engage in hands-on activities; have had training in teaching laboratory skills, diverse learners, and higher-order thinking skills; and administer point-in-time tests. Vasquez also states:

[Effective science teachers] have the ability to: recognize and probe for students' preconceptions based on their everyday experiences and intuitive notions, understand what it means to "do science," and provide opportunities for students to take a metacognitive approach to learning. Beyond these three guiding principles, effective teachers of science have classrooms that are learner-centered, knowledge-centered, assessment-centered, and community-centered. (2008, p. 7)

Few past studies have tried to identify knowledge, skills, and dispositions specific to science instructors, let alone elementary science educators. Hammerman (2006), in her step-by-step approach to high quality science instruction, states that effective science teachers: Know the structure of their discipline and are able to use it to guide assignments and assessments; select appropriate strategies and questions throughout the instructional process; know the difficulties that students are likely to face; address prior knowledge and misconceptions; understand

students' ways of knowing and thinking; know how to link prior knowledge with new knowledge to make learning meaningful and build deeper understanding of concepts and principles; know how to assess student progress and use assessment as a learning tool; and know how to prescribe appropriate channels for relearning or extended learning. According to the American Association for the Advancement of Science (AAAS), in order for science teaching to be effective, teaching should be consistent with the nature of scientific inquiry, should reflect scientific values, should aim to counteract learning anxieties, should extend beyond the school, and should take its time (1990). The National Science Teachers Association (NSTA) states that effective elementary science teaching happens when students are involved in science inquiry on a daily basis (2002). NSTA also states that effective elementary science teachers: Have positive attitudes toward self, society, and science; realize that assessment is essential in the science classroom; actively participate in science-related professional development; are aware of current scientific research; accommodate diverse learning styles; recognize contributions from all ethnicities; integrate science with other subjects; and model inquiry and positive attitudes for students (2002).

Why continue to separate preservice and inservice teachers, and consequently the university and school settings, when studying knowledge, skills, and dispositions? The researcher proposes that educators study both simultaneously so that educators may collaborate to foster effective science teaching within the classroom. Additionally, although researchers have studied the dispositions of elementary preservice and inservice teachers, many do not study their own perception of ideal dispositions of science teachers, or those of school administrators who hire, evaluate, and tenure teachers. The researcher wishes to study these perceptions from personnel in the university and school setting in relation to effective science instruction. Therefore, the researcher will study perspectives from both the elementary school and

institutional settings. The researcher will now discuss, specifically, the roles administrators, science teacher educators, and Professional Development Schools play in effective science instruction, and how they may affect knowledge, skills, and dispositions of elementary science teachers.

Administrators' Role in Elementary Education

From the elementary school setting, this study also considers elementary administrators and their perspective of science teacher knowledge, skills, and dispositions and teacher attitudes towards science. Many teachers realize that without the support of their respective principals or assistant principals, particularly in grade levels where math and reading are emphasized due to high stakes testing, they are limited in terms of science instruction within their classrooms. Although elementary administrators' published views are limited, in regards to elementary science knowledge, skills, and dispositions, there are a few studies that have attempted to provide a foundation for the study of administrators and their role in science education.

Eiss, a Science Education Specialist, attempted to inform readers of the administrator's role in education, due to an increase in public interest in science education programming, at the time of the National Defense Education Act (1962). He states that principals or administrators are the middlemen in education, bridging the gap between school districts and the local schools, between parents and teachers, and also between the school and the community. Specifically, in regards to effective science teaching, he notes:

One of the most serious handicaps to an adequate elementary science program is the complete feeling of inadequacy toward science experienced by most elementary teachers. Many teachers are aware of their lack of proficiency in this area. Because they think of

science as a body of knowledge, they hesitate to make any attempt to begin a science program in their classrooms. If the administrator can break through this barrier, he will find that these teachers may become some of his most enthusiastic advocates of a strong science program. (Eiss, 1962, p. 171)

The researcher suggests that administrators provide inservice programs for science education and designate a science supervisor or specialist, who could easily be a classroom teacher already employed at the school. Eiss (1962) emphasizes that the administrator's cooperation is needed to provide a high-quality elementary science program.

NSTA and the Principal's Role in Science Instruction

In 1983, the National Science Teachers Association (NSTA) issued a series of handbooks, entitled "Promoting Science Among Elementary School Principals," to inform principals of methods for identifying and maintaining effective elementary science programs within their schools (Mechling & Oliver, 1983). The four handbooks also sought to provide administrators with a means for evaluating and assessing their current elementary science programs (Mechling & Oliver, 1983). This series of handbooks was groundbreaking, in that it was dedicated to focusing on the role of the principal in the success of science education programs. Mechling and Oliver's project findings will now be discussed (1983).

"Science Teaches Basic Skills"

The first handbook, entitled "Science Teaches Basic Skills," stresses the importance of science as a subject to elementary principals. According to Mechling and Oliver (1983a), science teaches basic and lifelong skills that are also useful in content areas such as mathematics, social studies, language arts, and reading. They state that science skills are also useful in music and art. Mechling and Oliver (1983a) note:

Science is basic to the elementary school because through it we can help children to learn to ask significant questions, to seek relevant answers, to apply problem-solving skills to everyday life, to think rationally, to test ideas, to make decisions, to investigate, to try and fail and try again. (p. 2)

Science requires other essential skills such as: critical thinking, communicating, predicting, and inquiry (Mechling & Oliver, 1983a). These skills are learned in the early years, but are utilized over the span of one's lifetime. Mechling and Oliver (1983a) imply that although principals may be sensitive to the teaching of science, they may not be knowledgeable of the skills that are learned and acquired through science instruction. In addition to science process skills, the authors also note that a positive attitude is needed as well (Mechling & Oliver, 1983a).

Possession of certain process skills and a positive attitude can influence science teacher dispositions, and can also influence children's own attitude towards the subject of science.

"The Principal's Role in Elementary School Science"

The second handbook, "The Principal's Role in Elementary School Science," helps elementary administrators realize how important they are to the success of science in their schools, and also outlines for administrators the many responsibilities they may undertake to ensure effective science programs in their schools (Mechling & Oliver, 1983b). Obviously, the success or failure of a school lies in the hands of the principal or lead administrator. The authors share an unfortunate actuality: Principals are often overlooked when focusing on science reform, and the education system has suffered as a result of this neglect (Mechling & Oliver, 1983b).

Mechling and Oliver (1983b) also note:

While principals are responsible for providing top-quality science experiences for the children who attend their schools, many feel that they aren't well qualified to supervise

science instruction. And, for many, science ranks low on the totem pole in comparison with other subjects. Though principals are curriculum leaders, they certainly are not required to be experts in science to be effective. (p. xi)

Little has changed, in regards to ensuring that administrators know how vital their role is for effective science education within their schools.

Mechling and Oliver (1983b) have provided seven roles that principals should possess for effective science programs. These roles include: science leader; science curriculum analyst; force in the selection or development of a new science curriculum; provider of the wherewithal; provider of inservice instruction; monitor of science program progress; and troubleshooter. If the principal is to be a science leader within the school, he/she must show an interest and excitement for science so that the same interest and excitement may be passed down to the school's teachers and students; they must also stress the importance of science as a subject (Mechling & Oliver, 1983b). The authors suggest that there be open discourse with teachers, in relation to science, and that principals are visible, in the classroom, when science is being taught. Administrators should also assist in finding local resources to supplement science instruction, insist that science is being taught regularly in the classroom, and communicate with local institutions in terms of the progress of science within their schools (Mechling & Oliver, 1983b).

As the science curriculum analyst for the school, the principal must evaluate the current science program and its effectiveness. Principals must be aware of the district, state, and national mandates and requirements in science instruction, and school goals must be examined and/or created. The principal should also be aware of the science inventory, such as textbooks, materials, and equipment. It is also suggested that principals survey teachers' opinions of science

and question their students to garner a feel for their interest in the subject of science (Mechling & Oliver, 1983b).

Administrators are also often involved in developing or selecting new science curriculum. Mechling and Oliver state, “The decision to adopt or develop a new curriculum is especially important since it will have an impact on what is taught in science, how it’s taught, and how children will be evaluated” (1983b, p. 10). To assist with curriculum selection or adoption, a committee created by the principal should be generated. The committee assists the principal with establishing common goals and objectives and obtaining sample materials for examination (Mechling & Oliver, 1983b).

Teachers often express frustration as a result of a lack of resources to teach science. As the provider of the wherewithal, principals must search for funds and resources and ensure that science is represented in the school’s budget. Principals must also simplify the process for obtaining science materials for teachers. Costs for science professional development or inservice programs should also be included as principals consider funding for science (Mechling & Oliver, 1983b).

When considering inservice programming for their schools, Mechling and Oliver (1983b) assert that principals survey teachers to guarantee that they are receiving what is needed in relation to science instruction. It is also necessary for principals schedule inservice programs when new curriculum is selected. Oftentimes teachers are given new materials without the proper training to assist them in the classroom. This will help to improve self-confidence in the teaching of science among instructors. Again, the authors suggest working closely with local colleges and universities. Most importantly, the administrator must not take a back seat to inservice programs.

Instead, he/she should be visible and actively involved in what is being learned (Mechling & Oliver, 1983b).

As with other subjects, the principal must gauge the progress of the science program on a regular basis. The science program must be evaluated to determine if initial goals are objectives are being met. In addition to determining teacher effectiveness in science instruction, whatever forms of student assessment for science should also be viewed and analyzed (Mechling & Oliver, 1983b).

Lastly, the principal must also be able to take on a troubleshooter role in regards to science instruction. Teachers have various reasons for not teaching science: lack of confidence, lack of pedagogical content knowledge, or simply a dislike for science as a subject.

Administrators are obligated to stress the importance of science and to ensure that science is being taught when scheduled. To reduce these strains, principals are encouraged to interview and hire teachers that recognize the importance of science and enjoy teaching it as well. Principals can also assist teachers in using various forms of assessment within the classroom, such as rubrics and checklists, as well as the expected paper and pencil tests (Mechling & Oliver, 1983b).

“Characteristics of a Good Elementary Science Program”

The third handbook, “Characteristics of a Good Elementary Science Program,” is separated into two parts (Mechling & Oliver, 1983). The first section, entitled “Principal’s Checklist of Characteristics of a Good Elementary Science Program,” provides a checklist for administrators that allows them to simply check *yes*, *no*, or *no data*, and is presented in the form of questions so that principals may assess the effectiveness of their elementary science programs (Mechling & Oliver, 1983c). Four main sections comprise the checklist: administrative features,

science textbooks and other written materials, classroom observations, and resources and facilities. The authors are able to provide ideal characteristics based on their own observations and previous research at the time. The purpose of the second section, “Elaboration of the Principal’s Checklist of Characteristics of a Good Elementary Science Program,” is to expound on the checklist that has previously been provided by the authors (Mechling & Oliver, 1983d). Detailed recommendations and suggestions were provided to assist principals in improving weaknesses found in analyzing their checklists.

“What Research Says About Elementary School Science”

Finally, the fourth handbook, “What Research Says About Elementary School Science,” discusses various research studies and how those studies may relate to improving science programs in administrators’ schools (Mechling & Oliver, 1983e). The authors also stress the importance of and science and technology’s dependence on research. They note that research shapes what is taught in the elementary science classroom.

Administrative Support for Science Teachers

Recent studies and works also have recognized the need to focus on not just science teachers, but those that are closely related to science teachers, or those that can heavily influence them (Darling-Hammond & Sato, 2006; Klentschy & Maruca, 2006; Saginor, 2006). These studies agree with Mechling and Oliver (1983), in that science education reform in the schools is more likely with the support of the building principal. Saginor specifically states that the principal as leader must:

[M]anage the culture of change and build professional learning communities; cultivate teacher-leadership; advocate for science to be taught in elementary school to support literacy; provide for proper professional development; understand standards-based

science so when he or she knows what to look for when observing a class; [and] have tools to supervise teachers in the best instructional practices for producing enduring learning and deep content in science. (2006, pp. 164-165)

Additionally, although teachers are responsible for making sure that their students are learning science within their classrooms, principals must be responsible for professional development, mentoring, and ensuring that their teachers meet the high standards that educators often expect from their students (Darling-Hammond & Sato, 2006; Saginor, 2006). The implementation of the suggestions given by the previously mentioned researchers and authors, even as far back as Eiss (1962), will aid administrators in shaping desired knowledge, skills, and dispositions in the elementary science educator.

In a study conducted by Lewthwaite (2004), the researcher originally sought to unearth factors influencing science instruction delivery within one elementary school. After a questionnaire was repeatedly administered on how science curriculum is implemented within the school, the researcher found that teachers were greatly troubled by the principal's role on science delivery within the classrooms. Lewthwaite states, "In East School's case, the lack of instructional leadership by the principal had been identified as the major hindrance to the development of a shared institutional value towards instructional improvement, specifically within the area of science" (2004, p. 144). As a result of staff discussion, led by the principal, the entire school staff made the following decisions: Ensure that science was taught regularly; increase the amount of outdoor science-related activities; allow the science curriculum leader to serve as the science teacher leader as well; increase resources for the science program; and restructuring the principal's role as both a school leader and an advocate for curriculum improvement (Lewthwaite, 2004).

In August of 2008, science teachers of every grade level, and their principals and district supervisors, met for a summer institute on science instruction (Cavanaugh, 2008). Teachers verbally noted that their participation in the academy was beneficial, but not as worthwhile without the attendance and support of their principal. The academy met for three consecutive summers, and longed to increase the science content knowledge of principals. One principal noted the importance of her being in attendance, and shared that her goal was for her and her staff to share and learn together. She made the first step of acknowledging the importance of science instruction within her school (Cavanaugh, 2008).

Principals play an essential role in elementary schools, often bridging the gap between teachers, parents, and other educational constituents. In the study of elementary science teachers' knowledge, skills, and dispositions, their role is just as significant. Whether realized or not, they can directly and indirectly affect the change or development of teachers' attributes regarding science instruction. Principals frequently make most of the decisions in their schools, concerning elementary science education. These choices, made by the administrator, can often shape the dispositions of the school's elementary science teachers.

Science Instruction and the No Child Left Behind Act

Perhaps administrators' insistence on not focusing on science instruction can be blamed on the influence of the No Child Left Behind Act (NCLB). With the emphasis being placed on reading and mathematics instruction, science often gets left behind (Griffith & Scharmann, 2008). In a study to determine the effectiveness of the NCLB, the Center on Education Policy found:

Seventy-one percent of the school districts we surveyed reported that they have reduced elementary school instructional time in at least one other subject to make more time for reading and mathematics—the subjects tested for NCLB. In some case study districts, struggling students receive double periods of reading or math or both—sometimes missing certain subjects altogether. Some officials in case study districts view this extra time for reading and math as necessary to help low-achieving students catch up. Others feel that this practice has shortchanged students from learning important subjects, squelched creativity in teaching and learning, or diminished activities that might keep children interested in school. (2006, p. 2)

Researchers of an unidentified Midwestern state sought to discover the influence of the NCLB on their K-6 science education program (Griffith & Scharmann, 2008). A web-based survey was administered to gain elementary teachers' responses regarding science instruction in their classrooms. Over half of the teacher participants admitted to decreasing the time allotted for science instruction since the implementation of NCLB, and over half of the teachers stated that they taught science for less than ninety minutes per week. Still others maintained that school administration had strongly encouraged a decrease in science instruction, or for science not to be taught at all (Griffith & Scharmann, 2008).

Science Teacher Educators

In addition to principals, those that teach elementary science methods courses can also be influential in the development of ideal dispositions for elementary science teachers. Flick notes, “Working with teachers is one of the central roles of the elementary science teacher educator” (2005, p. 19). These professors are often the ones that are the first to notice if their students have

the knowledge, skills, and dispositions that are needed to be effective teachers in today's schools. The elementary science teacher educator's job is significant in that his/her class is often the single course students may take in preparing them for the teaching of elementary science (Olson & Appleton, 2005). Studies have been conducted in an effort to improve science methods courses and science teacher education for elementary inservice teachers.

In an effort to discover if elementary science methods courses were effective, Smith and Gess-Newsome (2004) conducted interviews, analyzed course syllabi, and studied readings assigned by professors. Local and national elementary science education teachers' perceptions of high-quality science instruction were recorded, and the objectives and goals of the courses taught were recorded. Syllabi were analyzed against the six teaching standards from The National Science Education Standards (NSES); these standards provided a framework for the study (see Table 2) (National Research Council, 1996). The interviews served in determining whether professors' teaching philosophies and depiction of their courses matched with their course syllabi and assigned readings. The researchers found that although the structure of the methods courses was similar, professors differed in their teaching philosophies and objectives for the courses. In their opinion, these disparities account for the many variations of elementary science teacher preparation (Smith & Gess-Newsome, 2004).

Table 2

NSES Teaching Standards

Standard	Description
A	Teachers of science plan an inquiry-based science program for their students.
B	Teachers of science guide and facilitate learning.
C	Teachers of science engage in ongoing assessment of their teaching and of student learning.
D	Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science.
E	Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning.
F	Teachers of science actively participate in the ongoing planning and development of the school science program.

Ellis (2001), in his own account as an elementary science teacher educator, found that students enrolled in his courses often had limited or no confidence in their own scientific knowledge or ability. He holds high standards for beginning elementary science teachers, expecting them to be competent in science teaching, science knowledge, learning, curriculum, assessment, and in classroom practice. On the other hand, he openly admits, "...I feel that a course that addresses the concerns of my students is not the same as one that will best prepare them in the knowledge and abilities dictated by the standards" (Ellis, 2001, pp. 253-254). Ellis

(2001) feels torn between addressing the concerns of his students, while at the same time not ensuring their competence, versus providing a course that addresses the necessary standards, but does not attend to their shortcomings or feelings of inadequacy.

Ellis's (2001) thoughts are truly justified. In studies of science methods courses and self-efficacy, researchers have found that efficacy in science teaching is closely tied to the successful completion of clear and coherent elementary science methods courses. These methods courses are supplemented by the students' participation in lab or field experiences (Roberts, Henson, Tharp, & Moreno, 2000; Wingfield, Freeman, & Ramsey, 2000).

Elementary science preservice students may not be the only educational constituents to be frustrated in their path to effectiveness in science teaching. As previously mentioned, Ellis (2001) voiced concerns regarding providing his students with what they need and want. Moscovici and Osioma (2008) openly admit their apprehension in creating an elementary science methods course in an urban area. With roots in secondary science education, they realized their lack of knowledge in elementary science education. They considered elements such as the fear of science, personal experiences, and professional literature in elementary science education as they created their ideal course for elementary science preservice teachers. In their self-study, Rice and Roychoudhury (2003) also reflect on their teaching practices to ascertain if students are receiving the necessary tools to be effective, in science instruction, once they acquire their own elementary classrooms.

Finally, Kelly (2000) states that in order for elementary science methods courses to be successful, educational constituents must not only pay attention to science reform, but must also ensure that preservice students are involved in act of *doing* science. Simply put, she affirms that elementary science methods courses must be constructivist in nature. Students must learn science

content knowledge while still engaging in activities that support the knowledge that is gained. It is Kelly's hope that preservice teachers would continue and carry over these constructivist views once they are in their own classrooms (2000).

Research on the effectiveness of elementary science methods courses is essential. By conducting studies in this area, educators may determine their effectiveness which will influence science teaching in elementary classrooms. Successful science methods courses will, in turn, positively affect the development of desired knowledge, skills, and dispositions among elementary science preservice and inservice teachers.

Elementary Science Education and Professional Development Schools

The Professional Development School (PDS) has been widely researched and has gained the support of many in the education community. The PDS is designed so that university faculty and schools have close relationships. According to NCATE, "Professional developments schools are innovative institutions formed through partnerships between professional education programs and P-12 schools. Their mission is professional preparation of candidates, faculty development, inquiry directed at the improvement of practice, and enhanced student learning" (2001, p.1). In addition to their students, professors are visible within their local schools, as research, collaboration, and open communication are key and essential to the success of the PDS. The central purpose is to improve the teaching practice (Darling-Hammond, 2005; Marlow, Kyed, & Connors, 2005; Ridley, Hurwitz, Hackett, & Miller, 2005; Castle, Fox, & Souder, 2006). However, educational constituents' attempt to achieve this purpose or objective has not been unproblematic. Colburn (2003) states:

Universities and K–12 schools are very different institutions with different goals and ways of rewarding faculty members for their work. It is difficult to blend their two cultures. It also seems to be rare to find a single site effectively combining K–12 teaching, prospective teacher training, inservice teacher professional development, and research. (p. 75)

Colburn also equates the PDS to a hospital. Instead of doctors, future doctors, and researchers, the PDS brings together teachers, future teachers, and teacher educators (2003). All members of the Professional Development School should benefit as a result of participating (Marlow et al., 2005).

Significance of the PDS in Teacher Education

Is the PDS concept successful? Studies have been conducted that question the effectiveness of the PDS in education. In one study, researchers sought to determine if a PDS-based teacher education program, for elementary education students, was more effective than a traditional, campus-based teacher education program (Ridley, et al., 2005). (Unlike their PDS-based counterparts, students that were campus-based completed all coursework on campus, with the exception of their methods courses; PDS-based students completed coursework and methods courses at the PDS site, and received supervision and clinical feedback throughout their entire program. Campus-based students only received supervision and clinical feedback while student teaching.) Ridley et al. (2005) hypothesized that students and graduates of the PDS-based program would excel in terms of lesson-planning, teaching effectiveness, and being reflective practitioners, as opposed to those in the campus-based program. However, they thought that both program participants would be equal in the amount of content knowledge that was attained. First-year graduates of the PDS-based teacher education program scored significantly higher when

tested on lesson-planning and teaching effectiveness. Both groups of beginning teachers scored similarly in regards to being reflective in their planning of lessons (Ridley et al., 2005).

PDS Effectiveness in Schools

To determine the effectiveness of Professional Development Schools, another group of researchers compared areas of planning, instruction, professionalism, management, reflection, and assessment among post-baccalaureate PDS and non-PDS preservice teachers (Castle et al., 2006). Participants in the PDS program consisted of students enrolled in classes held during the day, while the non-PDS track students took their classes in the evening, up until the time they became student teachers. The researchers used student teaching evaluation forms and recordings of students' portfolio presentations as primary sources of data, and the actual student portfolios and notes from portfolio interviews as secondary sources. PDS-based teacher candidates displayed more competencies in areas of instruction, management, and assessment. According to Castle et al., "[They were also found to be] more integrated and student-centered in their thinking and planning, assessment, instruction, management, and reflection" (2006, p. 78). The researchers' study supports that students in the PDS-based program were more likely to be prepared to teach in their own classrooms than non-PDS teacher candidates (Castle et al., 2006).

In another study of the effectiveness of Professional Development Schools, researchers gathered perspectives from teacher education faculty (Dangel, Dooley, Swars, Truscott, Smith, & Williams, 2009). Researchers conducted interviews with university faculty, attempting to gain responses regarding their activities, experiences, and roles in relation to PDSs. They also desired to obtain their perceptions on PDSs being a vehicle for change among the education community. Dangel et al. note, "All participants emphasized five ways in which PDS involvement changed their professional lives – namely, in their roles, teaching, thinking and learning, interests, and

research” (2009, p. 7). Professors were visible within the local schools, frequently interacting with teacher candidates, children, and school administrators. In regards to teaching, university faculty stated that they were more prone to spend more time preparing for instruction, ensuring that they included the needs of K-12 students in their courses. University faculty also admitted to being able to learn from even being in the PDS environment, increasing their understanding of the PDS itself, their colleagues, and in the understanding of their student interns. In terms of professors’ interests, they generally stated that they enjoyed being in the PDS environment and became increasingly aware of school-related issues. Lastly, faculty’s perspectives were similar in their responses in relation to research. Many faculty members stated that being in PDSs increased their accessibility to research and influenced future research topics. As a result of being a PDS, schools reflected positive changes in teachers, students, and professional development opportunities (Dangel et al., 2009). Assuring the effectiveness of the PDS is an ongoing process for all those involved, and requires further research.

PDSs and Elementary Science Education

Research of the PDS, and its relation to science education, is also necessary. Howes (2008) worked with lower elementary teachers at an urban PDS located in the eastern portion of the United States. The researcher labeled herself as a participant observer, regularly taking part in monthly teacher study groups, observations in various classrooms, co-teaching in an after-school science program. Howes (2008) also took part in PDS-related meetings, conferences, and projects. She conducted interviews as well, that stemmed from the monthly study groups. The researcher hoped to both learn with and from the teachers involved. Howes aimed to utilize these real-life applications and experiences to inform science instruction with her preservice teachers (2008).

In a study of a PDS partnership and elementary science education, one researcher chose to blend the PDS model with the National Science Education Standards (National Research Council, 1996). With the success of PDSs in many pre-Kindergarten through twelve schools, Bell (2002) hypothesized that the PDS model, tied with the NSES, may help to improve science education and elementary science teaching. Bell chose elementary science education as a focus for the study for a number of reasons:

- (a) Lack of attention to science at the elementary level;
- (b) Limited preparation of elementary teachers in science and inquiry-based pedagogy;
- (c) Current emphasis on problem-solving and critical thinking in all areas of education for all children;
- (d) Planning a vision of science as a route of choice and achievement for all children;
- (e) Scientific literacy that enhances daily living and eventual career choices; and,
- (f) Resultant longitudinal effects. (2002, p. 10)

In an effort to improve areas of science, mathematics, engineering, and technology education in Texas, a partnership was formed between an institution, two school districts, and a local health center. Using a constructivist approach, teacher candidates were enrolled in an inquiry-based, elementary science course and worked with second through sixth grade students and their classroom teachers. Bell's (2002) purpose was to establish how hands-on and inquiry-based lessons considerably affected preservice and inservice instructors' teaching practices. In terms of teacher candidates, the more they were exposed to being actively involved with inquiry-based lessons, the more they showed gains in learning. Inservice teachers' science beliefs and attitudes were increased as a result of being involved in the PDS. Like preservice teachers, they also showed significant gains in learning when actively engage in inquiry-based teaching (Bell, 2002).

Through the discussion of Professional Development Schools, the researcher of this current study wishes to stress the importance of collaboration among teacher candidates, science teacher educators, and elementary administrators. Many schools in the area of the researcher's institution are linked through PDS relationships. Consequently, the PDS is a vehicle for collaboration on findings to help elementary preservice and inservice science teachers, with whom the institution is actively involved. The honing of elementary science teacher dispositions will call for a conscious effort from all educational stakeholders. For this reason, the researcher has decided to study the perspectives of each of these educational constituents, in relation to elementary science teacher knowledge, skills, and dispositions.

CHAPTER THREE
TEACHERS, PRINCIPALS, AND PROFESSORS' PERSPECTIVES
OF IDEAL ELEMENTARY SCIENCE TEACHER
KNOWLEDGE, SKILLS, AND DISPOSITIONS:
A CASE STUDY ANALYSIS

Introduction

Teacher Dispositions

Teacher education programs now utilize knowledge, skills, and dispositions as considerations in determining effective preservice and inservice teachers. The justification of dispositions in higher education institutions has been brought about by accrediting organizations such as the National Council for Accreditation of Teacher Education (NCATE) and the Interstate New Teacher Assessment and Support Consortium (INTASC). According to NCATE, dispositions are defined as: “Values, commitments, and professional ethics that influence behaviors toward students, families, colleagues, and communities and affect student learning, motivation, and development as well as the educator’s own professional growth” (2006, p. 53). NCATE and INTASC have both stated that teachers must possess a number of dispositions, such as the belief that all children can learn and fairness, in order to teach students effectively (Smith, Knopp, Skarbek, & Rushton, 2005; Thornton, 2006; Koeppen & Davison-Jenkins, 2007).

In 1992, INTASC, consisting of a team of teachers and education representatives, created a list of knowledge, skills, dispositions, and corresponding standards that all beginning teachers

should have. These standards were also created to help assist teacher education programs in developing effective classroom teachers as they transition from higher education institutions to their first teaching assignments. The standards include: understanding of concepts, inquiry, and discipline; understanding of child development and learning; use of differentiated learning and instruction; understanding and use of various instructional strategies to develop critical thinking, problem solving, and performance skills; individual and group motivation of students; use of verbal, nonverbal, and media communication techniques; use of instructional planning based on content, students, community, and curriculum goals; use of formal and informal assessment strategies; being a reflective practitioner; and the maintenance of healthy relationships with educational constituents for the sake of the student. In having this knowledge and skills, teachers will be able to prepare students for the knowledge and skills needed for the 21st century (INTASC, 1992).

NCATE's attention to teacher dispositions in 2006 heightened the level of awareness, as well as significance, for teacher education programs, school districts, and other education entities. Although they only specifically identified fairness and the belief that all students can learn as the dispositions necessary for teacher candidates, NCATE also suggests that teacher education programs refer to INTASC to identify the specific dispositions that beginning teachers should have upon beginning the profession (NCATE, 2006). Studies have been conducted, past and present, to echo the sentiments of INTASC and NCATE in stressing the necessity of studying teacher dispositions as factors of effectiveness in teaching.

In 1931, Cattell asked directors of education, school inspectors, college faculty, elementary and secondary teachers and assistant teachers, preservice teachers, and students in high schools to pinpoint the ten most imperative attributes for new and veteran teachers. In order

of importance, participants identified the following dispositions: personality and willpower; intelligence; sympathy and tact; open-mindedness; a sense of humor; idealism; general culture; kindness; enthusiasm; knowledge of psychology and pedagogy; classroom technique; perseverance and industry; self-control; enterprise; orderliness; knowledge of subjects; outside interests; physical health; presence; social fitness; and an alert mind (Cattell, 1931).

Equally significant are those more recent studies conducted related to teacher dispositions. Studies involved researchers observing and interviewing preservice and inservice teachers to obtain dispositional qualities and helped education faculty identify a list of dispositions that they considered essential for effective teachers (Mullin, 2003; Hillman, Rothermel, & Scarano, 2006; Johnson & Reiman, 2007). Mullin's qualitative study utilized interviewing methods to examine preservice teachers' dispositions (2003). Hillman et al.'s (2006) study required education faculty to create a list of dispositional qualities that should be evident in students before leaving their teacher education program. Johnson and Reiman (2007) enlisted beginning teachers to be interviewed, observed, and assessed, through multiple-choice testing, on their moral and ethical judgment in teaching. These studies identified dispositional qualities in preservice and inservice teachers, and were utilized to guide instruction and improve teacher education programs in post-secondary institutions.

Dispositions in Teaching Science

With the United States lagging behind other countries in the area of science and mathematics instruction, teaching effectiveness has come under recent fire (Miller & Davison, 2006). To remedy this significant problem, a team of teachers, superintendents, professors, legislators, and state agency representatives met to form and create what has been called the Glenn Report (2000). In this significant piece, the twenty-five educational constituents appointed

by the U. S. Secretary of Education noted the following as reasons for restructuring in science and mathematics teaching: the urgent need for increased knowledge of science and mathematics-related knowledge for career preparation and ability to compete globally; to allow citizens to make daily decisions based on science and mathematics knowledge; to solidify science and mathematics' link to national security; and because science and mathematics are both imbedded in the nation's history and culture (Glenn, 2000).

The need for improved science instruction has been stressed, but an even narrower focus must be brought to elementary science teaching effectiveness. A lack of teaching effectiveness in science has been attributed to: a neglect or avoidance of science instruction; limited resources and time; low self-confidence in teaching science; lack of scientific content knowledge; and teachers' perceptions of themselves as learners (Appleton, 2007; Howes, 2002; Jarrett, 1999; Jones & Carter, 2007; Miller & Davison, 2006). These factors particularly affect elementary science teacher dispositions. With these characteristics, teachers are more effective in science instruction, and therefore foster student learning.

According to The National Science Teachers Association (NSTA), effective elementary science instruction takes place when students are actively involved in science inquiry on a daily and consistent basis (2002). NSTA notes that an effective elementary science teacher also has the following characteristics: a positive attitudes toward self, society, and science; a realization that assessment is essential in the science classroom; actively participates in science-related professional development; an awareness of current scientific research; is able to accommodate diverse learning styles; recognizes contributions from all ethnicities; integrates science with other subjects; and models inquiry and positive attitudes for his/her students (2002). For these

reasons, teachers must be knowledgeable in the best practices of science instruction, so that they can adequately prepare students to function scientifically, as well as generally, in today's world.

In this particular study, attention is focused on the knowledge, skills, and dispositions of elementary science teachers. Elementary science provides the basis for future scientific study as students progress through middle and high school and institutions of higher education. This will also aid in improving the current status of education, as students make gains in science and mathematics education in today's society. Through the study of science teacher knowledge, skills, and dispositions, educators from various settings (schools and higher education institutions) can collaborate to ensure effective science instruction within classrooms. This case study focuses on the perspectives of practicing teachers, principals, and professors of elementary science education in one southeastern university community in regard to essential knowledge, skills, and dispositions needed for effective elementary science instruction. The following questions were at the heart of the study: (1) What do the education stakeholders (professors, principals, and teachers) of a local school system consider to be the ideal dispositions for effective elementary science teachers and teaching? and (2) what similarities and differences in perceptions exist between these stakeholders? After a synopsis of related literature, the methods, data analysis, and results will be discussed, followed by implications for further study.

Literature Review

Attitudes and Beliefs, Self-efficacy, and Teacher Confidence

The study of elementary science teacher dispositions is sparsely documented in research. However, a number of studies have been conducted regarding elementary science teacher attitudes, beliefs, and self-efficacy (including teacher confidence), and how they help to

understand related dispositions. In their analysis of previous literature, Jones & Carter found that science teachers' attitude and belief systems can directly influence their dispositions (2007). Although educational researchers have had difficulty in agreeing on common definitions for attitudes and beliefs, a few have attempted to perform this daunting task. Koballa states, "Attitude is commonly defined as a predisposition to respond positively or negatively toward things, people, places, events, and ideas" (2008, Attitude section, para 1). In defining belief, Czerniak, Lumpe, and Haney note, "Teachers' beliefs can be described as their convictions, philosophy, tenants, or opinions about teaching and learning (1998, p. 125)." The disagreement of a common definition for belief systems is mostly blamed on the fact that belief systems are often researched by various fields, therefore resulting in the array of meanings (Eisenhart, Shrum, Harding, & Cuthbert, 1988; Pajares, 1992). A few studies will now be shared in the area of science teacher attitudes and beliefs, self-efficacy, and in teacher confidence in science.

In a study conducted by Jarvis and Pell (2004), the researchers wanted to determine if a two-year science professional development course would have an effect on primary teachers' attitudes and confidence levels. Participants completed a confidence and attitude questionnaire, as well as a cognitive test that assessed their science content knowledge. The teachers' attitudes and confidence levels increased after being enrolled in a two-year science professional development course. In this instance, the increase in science pedagogical content knowledge positively affected the teachers' attitudes towards science.

Elementary science teachers of an Ohio school district had to become familiar with three new science kit-related curriculum materials during a professional development program. Teachers began the experience afraid to teach science and with a lack of confidence in science instruction. Upon completion of the professional development program, teachers' attitudes and

beliefs towards science became positive, and their confidence in teaching science also increased (Fetters, Czerniak, Fish, & Shawberry, 2002).

In relation to teacher attitudes and beliefs, Roberts, Henson, Tharp, and Moreno (2001) observed self-efficacy gains in elementary science teachers after completing a National Science Foundation (NSF)-, National Institutes of Health-, and Eisenhower-funded inservice program. Participants of the inservice program were taught science content knowledge and science inquiry skills through lecture, hands-on activities, and cooperative groups. Gains of self-efficacy were made for teachers who originally were not comfortable with teaching elementary science.

Science teacher confidence can also affect teachers' dispositions. Mulholland and Wallace's (2005) study followed one elementary science teacher's progress and growth in pedagogical content knowledge across a ten-year span. The researchers followed the participant from her time as a preservice teacher, to a beginning teacher, and lastly, as an experienced teacher. As she gained more experience teaching elementary science and being involved in science-related professional development, the teacher not only increased her scientific pedagogical content knowledge, but also gained more confidence in teaching the subject of science.

Science Inquiry

Being cognizant of science inquiry and its effectiveness also relates to effectiveness in teaching and science teacher dispositions. INTASC states that students understand science and become scientifically literate through inquiry-based experiences (2002). Teachers must be knowledgeable of science inquiry in order to effectively administer inquiry-based activities to their students. Inquiry takes place when students create questions and conduct investigations relating to their everyday world (National Research Council, 1996). The National Academy of

Science notes that in being involved in inquiry, students are able to design and conduct scientific investigations and have an understanding of the nature of scientific inquiry (2000). Students are taught strategies that assist them in mastering scientific concepts through investigations. A classroom that utilizes scientific inquiry ensures that students do the following: Ask questions about objects and events in their environment; conduct simple investigations; use appropriate tools and techniques to gather and interpret their data; use evidence found and scientific knowledge to develop explanations; and communicate those investigations, explanations, and data to other students, teachers, and family members (National Research Council, 1996). Teaching science through scientific inquiry is also characterized with ongoing assessment: at the beginning of the lesson (diagnostic), during the lesson (formative), and at the end of the lesson (summative) (National Academy of Sciences, 2000).

When teachers implement an inquiry-based approach to learning, students benefit in various ways. They are able to learn from their own experiences and cultures, real-world applications are employed, a number of learning styles are accommodated, and students participate in true collaboration and teamwork. Teachers are able to observe students grasp new knowledge throughout the lesson (Bransford & Donovan, 2005). Consequently, instructors also benefit from inquiry-based teaching. Teachers' self-efficacy is improved, and when a full understanding of inquiry-based teaching and learning is gained, they will also improve their self-confidence in teaching science (Richardson & Liang, 2008).

Subsequently, INTASC created a list of knowledge, skills, and dispositions for beginning K-12 science teachers that would help foster scientific inquiry and effective learning within the classroom (2002). These standards, or knowledge, skills and dispositions, include: content knowledge; student learning and development; student diversity; instructional variety; learning

environment; communication; curriculum decisions; assessment; reflective practitioners; and community membership (INTASC, 2002). The standards provided differ from the 1992 INTASC standards in that they are content-specific and provide guidance in best practices for beginning science teachers. Through content knowledge, beginning science teachers should be familiar with inquiry and various science disciplines (i.e., Earth and space science, biology, chemistry, and physics). Elementary science teachers should also know how students learn and develop, and teach with this knowledge in mind. They realize that students learn in various ways, and deliver instruction to cater to students' learning styles. Effective elementary science teachers also utilize various instructional strategies to promote critical thinking, problem solving, and performance skills among students. They understand individual and group motivation, and create positive social interactions of collaborative learning opportunities and opportunities for self-motivation. Teachers must also be able to communicate verbally, nonverbally, and through media for teaching effectiveness. The effective science teacher makes decisions regarding curriculum based on the makeup of students, curriculum goals, content, and the community. He/she understands the significance of utilizing both formal and informal types of assessment to develop learning in students. They realize the importance of self-evaluating their instruction, and seek out opportunities for continuing their own education. Lastly, effective science teachers create and build relationships with colleagues, parents, and other education entities for the benefit of his/her students. Because of their specificity in nature for science teaching, the standards provided by INTASC (2002) were used to analyze this study.

Participants and Context

The school district participants consisted of eight elementary science teachers and two principals of a small southeastern school district in close proximity to a land-grant university with a large teacher education college. Two schools (Jefferson Elementary and Rosebud Elementary) represented the school district in the study. These schools were chosen because they developed a close working relationship with the teacher education college involved in the study, and based on the fact that the teachers taught third through fifth grades – grades of interest to the researcher because science was regularly taught. Two elementary science teacher educators from a large southeastern university also participated. The science teacher educators that participated were associated with the teachers and their principals based on a Professional Development School (PDS) model, in which the professors were often visible within their schools. (For confidentiality purposes, pseudonyms have been used for participants' names and the names of their schools.)

Teachers

Eight elementary science teachers from two separate elementary schools participated in the study. The grade levels taught by the teachers ranged from grades three through five. Five teachers took part in the study from Jefferson Elementary, while three teachers participated from Rosebud Elementary (See Table 3). The researcher selected teachers to represent a range of grade levels present in each school. Teachers were also selected on the premise that they taught science on a regular basis. All teachers have self-contained classrooms; they teach and are responsible for the same students for the entire day. Teachers of Jefferson Elementary ranged from one to eleven years of teaching science, while Rosebud Elementary teachers' experience ranged from seven to twelve years.

Table 3 – This table represents teacher participant descriptive data.

Teacher Participants

Teacher	School	Grade Level Taught	Number of Years Teaching Science
B. Elsner	Jefferson Elementary	3rd	1
R. Davis	Jefferson Elementary	5th	11
L. Karwoski	Jefferson Elementary	4th	2
D. Gardner	Jefferson Elementary	3rd	2
M. Malone	Jefferson Elementary	3rd	4
T. McDowell	Rosebud Elementary	5th	11
J. Holston	Rosebud Elementary	5th	12
A. Douglas	Rosebud Elementary	4th	7

Principals

The schools in this school system are unique in that they only have head principals. There are no assistant principals. Dr. Chappell, the principal of Rosebud Elementary, taught fourth grade science for six years before becoming an administrator. The principal of Jefferson Elementary, Mr. Daniels, taught science and reading for two years within a departmentalized, middle school setting.

Science Teacher Educators

The professors, Dr. Miller and Dr. Scott, are the sole faculty members that teach science education courses to elementary science majors at the university. Dr. Miller began teaching secondary science methods courses (for seven years) before moving on to teaching elementary science methods courses for three years. He taught in middle and high school grades for almost ten years before becoming a science teacher educator. Dr. Scott has taught elementary science

methods courses for six years. She has also taught fifth grade science for four years before teaching elementary students through the National Aeronautics and Space Administration (NASA).

Relationship of Participants

The schools and college in this study interact with each other on a consistent basis, based on the PDS-type relationship that they have. The schools are also both used for elementary intern placements from the college, as well as laboratory placements during methods courses. The schools, Jefferson Elementary and Rosebud Elementary, are both considered intermediate schools since their grade levels range from three to five. Each teacher instructs students in self-contained classrooms, and science is taught on a daily basis, although some admit to not being to always teach it daily. The amount set aside for science instruction ranges from 30 to 45 minutes long. Teachers conduct lessons according to their state's course of study, including materials funded by the Alabama Math, Science, and Technology Initiative (AMSTI). AMSTI utilizes curriculum designed to improve mathematics and science instruction.

AMSTI Program

In 1999, the current State Superintendent of Education and Deputy State Superintendent of Education, at that time, determined that science and mathematics instruction needed to drastically improve (AMSTI, 2009). In the year 2000, a team of exemplary K-12 teachers and administrators, higher education representatives, as well as community business leaders, met to create the curriculum for Alabama Math, Science, and Technology Initiative (AMSTI). This program was designed to improve science instruction throughout the state of Alabama. Its aims to prepare all K-12 students with the skills and tools needed to excel in future careers and in further science and mathematics courses. AMSTI's belief is that students learn best by being

actively involved in science and mathematics instruction, especially when connections are made to students' everyday lives.

In order to be involved with the AMSTI program, schools must first apply, and once accepted, send teachers and administrators to a two-week professional development course, held during the summer, for two consecutive years. Since most elementary teachers are self-contained, or teach all subject areas, all elementary teachers attend the AMSTI training. Teachers spend at least 120 contact hours, learning content-specific information that is applicable to the grade taught. They then conduct the lessons while at the AMSTI training, before returning to their schools, where they receive all materials and equipment needed to implement the lessons within their classrooms, disseminated in tubs, or as AMSTI calls them, kits. These kits are rotated among the school, and are similar to other kit-based curriculum, such as Full Option Science System™ (FOSS) and Science and Technology for Children™ (STC), that are research-based, inquiry-oriented curriculum available for use in United States school systems. Each school also has lead teachers that specialize in AMSTI science and mathematics, for additional support (2009). Both schools in the study were involved in AMSTI, but not all teachers were AMSTI-trained, being that a few of them were new to their school. Principals receive minimal training.

Methods

Data Sources

After gaining consent from participants, the researcher conducted individual and focus group interviews to collect data regarding attitudes and opinions of elementary science teacher knowledge, skills, and dispositions. Individual, audio-taped, face-to-face interviews were

conducted for the principals and science teacher educators. The researcher chose to conduct audio-taped focus group interviews with the elementary science teacher participants at each school. Focus groups help to incite emotions and spontaneity about the topic at hand (Kvale, 1996). A list of guiding interview questions was utilized for each interview (See Appendix). Each participant was asked questions relating to their science teaching experience, length of time dedicated to teaching science, and beliefs about ideal elementary science teacher knowledge, skills, and dispositions.

A number of artifacts were collected as well. According to Schwandt, “An artifact is an object that carries meaning about the culture of its creators and users. Understanding and interpreting the composition, historical circumstances, function, purpose, and so on of artifacts are central to the study of material culture” (2007, p. 9). Elementary science teachers were also asked to submit lesson plans to supplement the study. Each teacher was asked to choose and submit a lesson that represented their most effective science lesson. Science teacher educators were asked to submit syllabi for their science elementary methods courses. These items were used to provide triangulation for their thoughts and perspectives of elementary science teacher dispositions (Schwandt, 2007). The researcher also kept a personal researcher journal to record thoughts and ideas related to implementation of the study. The journal provided a means of personal observations and realizations made during the researcher’s journey, as she conducted interviews and transcribed and analyzed data. According to Lichtman, a journal helps one self-reflect on his/her thinking and motivation, which affects is affected by research interests (2006).

Data Analysis

The data were analyzed within participant schools, including the university, as a multi-site study (Cresswell, 2007; Lichtman, 2006). The cases consisted of the teachers and principal at

each school. Individual cases were studied within a bounded system of the local university-teacher education program. Each school is considered as an individual case, along with its association with the university, and then studied across cases in comparison to the other school (Creswell, 2007).

The researcher conducted one focus group interview with the teachers at each school, resulting in two total focus group interviews. She also held an individual interview with each principal and science teacher educator. Interviews were transcribed and analyzed on the research questions previously stated (Kvale, 1996). The researcher sought patterns in responses as they related to elementary science teacher knowledge, skills, and dispositions and participants' attitudes and beliefs towards science instruction, and thematically coded accordingly. For example, one teacher stated, "Also, you have to be open-minded and willing to allow change. Many teachers have been doing the same things for years and they like what they are doing and do not want to change." The researcher noted that her response dealt with open-mindedness. She also realized that the response was related to a willingness to change. According to Charmaz:

In selective or focused coding, the researcher adopts frequently reappearing initial codes to use in sorting and synthesizing large amounts of data....These codes cut across multiple interviews and thus represent recurrent themes. In making explicit decisions about which focused codes to adopt, the researcher checks the fit between emerging theoretical frameworks and their respective empirical realities. (2002, p. 686)

Responses were coded as common themes that the researcher noticed that addressed the research questions. These emerging themes became evident during the initial and second coding processes. Emerging themes that were coded were placed in categories that addressed some facet of the INTASC Standards (knowledge, skills, or disposition) as the researcher compared and

contrasted codes based on patterns that became evident (Coffey & Atkinson, 1996; Creswell, 2007; Schwandt, 2007). Categories were then collapsed based on commonality in addressing an INTASC standard. For example, individual categories of planning, organization, and preparation were eventually combined into one category of *Planning, Organization, and Preparation*, since they are so closely related. In other words, the researcher reread the interview transcripts and combined categories that were similar. Next, quotations were lifted for similar categories and responses within schools and placed in a text document. Emergent categories were then compared to the INTASC (2002) standards for beginning science teachers, to ascertain whether they fit with each other (Creswell, 2007).

In regard to within-case study analysis, commonalities were noted within each school, or each case. Next, relating to cross-case study analysis, commonalities were noted by looking at both schools, or across cases (Creswell, 2007). Matrices were created to simplify and interpret data, separating information according to the school, and then combined for comparison purposes (Yin, 2003). Knowledge, skills, and dispositions identified by teacher and science teacher educator participants were then compared to their corresponding artifacts (lesson plans or syllabi) as corroborating evidence of thoughts, ideas, and perspectives (Yin, 2003; Creswell, 2007). Interpretations of the participants' responses and artifacts were made solely by the researcher. Data were triangulated by looking for common themes in teacher, principal, and science teacher educator responses, teachers' lesson plans, and science teacher educators' syllabi for elementary science methods courses.

Results

Although a number of knowledge, skills, and dispositions were mentioned by teachers, principals, and science teacher educators, the researcher has decided to focus on five main teacher attributes for the effectiveness of elementary science instruction. The researcher focused on these characteristics because they were commonly identified across cases – each school (teacher and/or principal) was represented, as well as representation from the university level (one or both professors). The knowledge, skills, and dispositions included: (1) a willingness to learn/open-mindedness; (2) having content knowledge; (3) having planning, organization, and preparation skills; (4) recognizing the importance of teaching science; and (5) being aware of various assessment strategies. The researcher has chosen to include one response or comment from focus group interviews at each school as a typical quote for the teachers at that school which represents the sentiments of the teachers in a particular category (Kvale, 1996). Principals and science teacher educators who concurred with teacher beliefs and disposition in a category were also quoted. Therefore, for each knowledge, skill, and disposition, there may be one or both principals' excerpts, or one or both science teacher educators' excerpts.

Willingness to Learn/Open-Mindedness

Teachers at both elementary schools, one principal, and one science teacher educator identified a willingness to change and open-mindedness as dispositions for effective elementary science teaching. The researcher noted that these dispositions were mentioned by educators from both elementary settings, but only one principal discussed it in the individual interview. In Dr. Miller's syllabus, students are expected to "model and nurture intellectual vitality" as a disposition toward professional commitment. In the following excerpts, participants responded to

being questioned on what dispositions were needed to be effective elementary science teacher and what made them effective as science teachers.

So like, in today's society teachers have to really have the mind-set to always...willing to improve and to find out better ways of teaching, especially in the field of science.

[Daniels, Principal, Jefferson]

I learned this year with my kids. I was like...I was learning things this year in science that I don't know that I've ever...I probably was taught at one time, but I don't remember it so, this year I was like, "Oh ok!..Yeah!" You know, "I'm learning something with y'all!" [Douglas, Teacher, Rosebud]

Well, see I think it's important that teachers be ongoing learners. [Scott, Professor]

Many educators, representative of all three groups, equated a willingness to learn or open-mindedness to being flexible and being open to change. Science teacher educators, specifically, desired that elementary science teachers be continuous learners, voluntarily seeking out ways to stay current on what is going on in the education world.

Content Knowledge

Teacher and science teacher educator participants also identified content knowledge as a disposition that is essential to effective elementary science instruction. Neither principal mentioned the need for elementary science teachers to have or develop this knowledge. Although teachers at both schools stated content knowledge as a disposition needed for elementary science teachers, most of the responses on the topic came from teachers from Jefferson Elementary. A few teachers admitted that they were still building on their content knowledge in elementary science.

I just feel like to be a better effective teacher I'm still building my background knowledge in science. Because my students will ask me the craziest questions, and I'm like, "Oh! I have to go look it up and get back to them the next day." Cause I don't want to tell them something that's wrong and not know. So I just feel like my background knowledge is just still building in science. [Elsner, Teacher, Jefferson]

Involvement in the AMSTI program also helped to increase content knowledge. Ms. Gardner, of Jefferson Elementary stated, "I have learned so much more in science due to the AMSTI kits." Additionally, science teacher educators expressed the need for content knowledge.

Um, I think there needs to be *some* basic understanding of science and how science works, and a *little* bit of science knowledge. But...but a large part of what you learn in science often comes on the go, and although people will argue...I just had this discussion the other day...saying, "Oh, secondary people really know their subjects so they're great. And elementary don't, so they have all these problems." And I'm like, "Ah...I taught secondary, and I was really great at what I knew, but I was a biology major. Did I know physics really well? Do I know astronomy? No! We learned it on the fly! I mean, we read and studied and took a quick course, and we taught it!" [Miller, Professor]

Although Dr. Scott makes no mention of content knowledge in her interview, in her syllabus for a science methods course for preservice teachers, the course objective stated that students would, "Demonstrate an understanding of environmental education and the ability to use community agency resources in planning and implementing an environmental lesson." Topics to be covered in the course schedule included: the inquiry process skills; earth science; life science; matter and motion; energy and machines; and rocketry and aeronautics. Dr. Miller's syllabus indicates:

“[The course] was designed to assist prospective teachers in developing the confidence and competence needed to begin teaching science as a hands-on, process approach in elementary classrooms. This competence involves a basic level of understanding of the subject matter and the inquiry nature of ‘doing’ and learning science...”

One of the course objectives for Dr. Miller’s syllabus called for students to develop competency and an enjoyment of science instruction. Both professors’ syllabi strongly supported the need for content knowledge for elementary science teachers.

Planning, Organization, and Preparation

Planning, organization, and preparation are also identified by Jefferson teachers, Rosebud teachers, and professors as essential for elementary science teachers’ effectiveness in instruction. It was not mentioned by the two participating administrators. Teachers and science teacher educators realized that planning, or lack of planning, can influence instruction within the classroom. They discuss the importance of planning, organization, and preparation in relation to effectiveness within the elementary science classroom:

I’ll go into what [Ms. Karwoski] was saying about planning...with the AMSTI kits, there *is* a lot of planning involved, and it’s nice cause [Ms. Malone] and I work really well together and when we get our kits out, I mean, we sit down with it together and we plan it...I mean, we get the stuff out. I help her check her kit, she helps me check mine...and I think that helps a lot too, because everything we do, we’ve planned together. [Gardner, Teacher, Jefferson]

There has to be some sense of a system or organization inside that person that enables them to plan and prepare and lay out what needs to be taught. Cause especially as a new

teacher. If you can't do that, it's *rare* that you're going to be able to wing it without experience as a brand new teacher. So I think that's important. [Miller, Professor]

Teachers from both schools also stated how the AMSTI kits helped them better prepare for science instruction. In Dr. Scott's syllabus, the ability to use technology for planning purposes is noted as a course objective. Class time is provided for learning how to effectively plan and manage science instruction, and three elementary science lesson plans must be submitted by the culmination of the semester. Dr. Miller's syllabus involves science instruction planning in the course description. Like Dr. Scott, a set of time is given during the course to prepare for co-teaching within the schools. Students must also submit two lesson plans prior to leaving the course.

Significance of Teaching Science

Representatives from all three groups (principals, teachers, and science teacher educators) have identified knowing the importance of science teaching as an essential disposition for elementary science teachers. Interestingly, from the elementary school setting, only teachers from Rosebud Elementary and the principal from Jefferson Elementary discussed the significance of teaching science. Participants realized that the subject of science must be taught in addition to other content areas within the elementary classroom.

That is important. Because sometimes...so many times science is not seen as important because it's not reading, math, or language. But for me, I think that it is important, but I've been guilty of that before...saying, "Oh Golly...this is what's going to...this is what I'm going to be as a teacher graded on: reading, math, and language...I have some students in here that where I know they're going to do something in the science field, and so it *is* important for them. And I need to look at it as being important,

and not just: It's that subject that I teach at the end of the day. [Douglas, Teacher, Rosebud]

Well, I'm pretty sure that...ah...a professor would think that science would be most important than the math and reading, because that's that one content area that he feels strongly about, and I can say, here in [this state] they've adopted...or here in [our city] we've adopted the AMSTI Program, which is a hands-on science program, to give our kids that literature and the hands-on experiments as well. [Daniels, Principal, Jefferson]

One of the things that I value is that I understand, and I want my students to understand that yes science is a content class, but it also offers so many other things in helping you deal with real life situations and real life application. There's problem-solving. You know we have to problem-solve and do things every day, and one of the statements I make to *my* class is that, "We're *all* scientists." Because every day we make observations, we do investigations, we experiment, we collect like data...So that's really important to me, to be able to use science as a vehicle for being able to operate in the everyday world. [Scott, Professor]

Mr. Daniels, the principal at Jefferson, and Dr. Miller, a science teacher educator, both made mention of AMSTI while discussing the importance of teaching science in the elementary classroom. They imply that the AMSTI program assists teachers in helping science remain relevant in schools. In Dr. Scott's response to the value of teaching science, she makes the realization that science is a part of the everyday world and is a part of life. In this, she notes the significance of needing to teach science as a subject. In Ms. Holston's (Rosebud Elementary) submitted lesson plan on using microscopes, she stated, "The students understood the importance

of taking a closer look at our world.” Here, the teacher realized the importance of teaching science, and disseminated this importance of science to her students during instruction.

Assessment Strategies

In both of the cases, participants noted that having knowledge of various assessment strategies is a vital disposition for elementary science teachers. Teachers’ submitted lesson plans showed that they all implemented formative assessment in their lessons; the teachers constantly assessed student knowledge while teaching. One teacher specifically described an example of summative assessment used in the lesson. Students were asked to describe and draw their thoughts and ideas at the end of the lesson. Teachers from both schools mentioned both formal (chapter tests and quizzes from textbook material) and informal (observations, conferencing, rubrics, checklists, science journals) assessment as being equally important when asked what type of assessments are used during their science instruction. Teachers also used summative assessment, by use of tests or quizzes that came after teaching a certain chapter or section. Formative assessment was used during instruction, such as observations, interviews, and conferences, to assess students’ comprehension during the course of the lesson.

I assess my students in a variety of ways-through formal assessments and informal assessments. I may have them take a quiz, interview them asking them to explain their thinking, or check their science journaling and look at their thoughts from there to check for understanding and any misconceptions. [Elsner, Teacher, Jefferson]

Well I think that there’s...there are places for, you know, actual written assessments, tests, and that kind of thing, but...you know, that’s...looking back when I was in school that’s pretty much the only way I was ever assessed. [Chappell, Principal, Rosebud]

Science just...of course your traditional testing is always there, and so it's not *not* there. But you don't want to rely strictly on that, and I used to always teach my teachers, and I still do, when they're doing a grading scheme, for final evaluations of their students, at *any* grade level really, be sure that you've got a spread of the types of the assessments and ways you go about knowing what kids know and can do. And at the elementary level you do a lot more visual and observation and check forms and interviewing and conferencing with students. [Miller, Professor]

Dr. Miller's course syllabus and course description indicated that students would be actively involved in planning for assessment and would also be introduced to alternative assessment strategies. Two course periods were dedicated to assessment in relation to scientific inquiry. Dr. Scott stated that students would be able to design and implement their own forms of authentic assessment after being enrolled in a science methods course. Like the other science teacher educator, Dr. Scott ensured that course time was devoted towards the discussion of inquiry-related assessment strategies.

Discussion

This study indicated that a willingness to learn/open-mindedness; content knowledge; planning, preparation, and organization; the importance of science teaching; and assessment strategies were identified as the knowledge, skills, and dispositions needed by elementary science teachers in order to be effective. The mention of knowledge, skills, and dispositions match some of those of INTASC: being reflective practitioners; content; learning environment; curriculum decisions; and assessment (2002) (See Table 4). Although the importance of teaching science is not mentioned in INTASC's (2002) standards and corresponding knowledge skills,

and dispositions, the National Science Teachers Association (NSTA) addresses this disposition indirectly in the organization’s standards for preparing science teachers (2003). According to the NSTA, upon finishing their education, preservice teachers must be prepared to teach the nature of science and recognize its value to society. The participants’ responses also address an issue stated in the Glenn Report (2000), in that educators realized that science was pertinent to career preparation for their students. The importance of the AMSTI program to all three groups (teachers, administrators, and science teacher educators) was also evident through their responses. Both elementary schools were participants of AMSTI, but not all teacher participants were AMSTI-trained at the time of the study (due to being new to their school).

Table 4 – This table represents the knowledge, skills, and dispositions identified in the study that correlate with INTASC’s (2002) standards for beginning science teachers.

<i>Correlation to INTASC Standards</i>	
Elementary Science Teaching Knowledge, Skills, and Dispositions Identified in Study	Corresponding INTASC (2002) Standards for Beginning Science Teachers
Willingness to Learn/ Open-Mindedness	Principle #9: Reflective Practitioners
Content Knowledge	Principle #1: Content Knowledge
Planning, Organization, and Preparation	Principle #5: Learning Environment
Significance of Teaching Science	Not applicable
Assessment Strategies	Assessment

INTASC states that science teachers who are reflective practitioners seek out opportunities to learn and inform their instruction (2002). They constantly try to build on their prior knowledge to improve student learning within their classrooms. Educators who

acknowledged a willingness to learn and open-mindedness as dispositions for effective elementary science teachers concur with what INTASC would call reflective practitioners. Mr. Daniels, principal of Jefferson Elementary, suggested that elementary science teachers be willing to try new methods of teaching, while Dr. Miller, science teacher educator, encourages teachers to take part in professional development opportunities whenever possible. These findings support previous literature, that states that having an open mind, a passion for learning, being reflective, and being responsible for one's on learning, can contribute to teaching effectiveness (Cattell, 1931; Mullin, 2003; Hillman et al., 2006).

Connected to this willingness to learn and open-mindedness is the need for content knowledge for effectiveness in teaching. According to INTASC (2002), beginning science teachers should be able to understand basic science concepts, inquiry-based teaching, and have knowledge of science disciplines (biology, chemistry, physics, and Earth and space science). Teachers are to use this knowledge to provide meaningful learning experiences for their students. Teacher participants noted that knowledge of the science content was needed for effective instruction. Some of the teachers even mentioned that they were learning the content along with their students, and needed to have improved content knowledge to be effective in their classrooms. Teachers were also involved in AMSTI training, professional development, to further their scientific knowledge and pedagogical content knowledge. As discussed earlier, some teachers expressed having more content knowledge because of being involved with AMSTI. However, teachers also felt like they still needed additional training with the AMSTI program. Science teacher educators included the learning of science content and inquiry in their elementary science methods courses. The findings align with previous literature that encourages

increased knowledge of pedagogy, and encourages professional development to increase scientific knowledge (Cattell, 1931; Jarvis & Pell, 2004; Klein, 2005).

Elementary science teachers must also be able to plan, prepare, and organize what must be taught in their classrooms. INTASC states that teachers must be able to plan lessons and materials effectively within the learning environment in order for students to gain optimal knowledge (2002). Participants of the study communicated that effective elementary science teachers plan and prepare for instruction. Teachers state that they plan their lessons, individually or with colleagues, before teaching, and that this planning is essential for effectiveness, to provide ease in science instruction. Professors provided course time for assistance on lesson planning and using technology to plan for instruction within elementary science classrooms. Cattell (1931) previously stated in his research that orderliness was needed, and Mullin (2003) supported the need for preparation for teaching effectiveness. Teachers from both elementary schools and Dr. Miller, a science teacher educator, also associated AMSTI training with preparation for science instruction. Teachers noted that AMSTI was effective, with proper training, even though it required extensive planning at times.

Participants of the study seemed to realize the importance of elementary science instruction within their local schools. Teachers, administration, and science teacher educators articulated that science be held in high esteem, even when compared to other content areas such as reading and mathematics. Dr. Scott, a science teacher educator, even discussed how science is all around us, is a part of everyday life, and can be utilized to hone problem-solving skills. Teachers equated the effectiveness of their lesson plans to the importance of teaching science. Again, INTASC (2002) does not have a corresponding disposition for beginning science teachers. However, in its official statement of elementary science education, NSTA (2002) states

that science must be part of the daily curriculum, and on every grade level within the school; Teachers are to ensure that children learn the skills needed to effectively problem-solve in today's world. When educating students in science, teachers must also help students acquire knowledge about their everyday world and train students how to think scientifically (Li & Klahr, 2006).

Lastly, participants discussed the need for various types of assessment strategies for effective elementary science instruction. Teachers mentioned that they use various types of assessment, both formal and informal: tests, quizzes, interviews, science notebooks, observations, journals, etc. INTASC (2002) states that teachers not only use these types of assessment, but that teachers realize that informal assessments (observations, interviews, journals science notebooks, etc.) are used to complement formal assessments (tests, quizzes, etc). Elementary administration and science teacher educators also agree that both types of assessment be used for effective elementary science instruction. These findings confirm NSTA's (2002) claim that teachers must realize the importance of assessment in science. In this study, educators not only realized its importance, but also realized the importance and need for various types of assessment as well.

These findings support previous literature on the study of science teacher attitudes and beliefs, in that educators' attitudes and beliefs shape their dispositions and practice concerning science instruction. Research has found that teachers' self-confidence in teaching science influences their teaching effectiveness (Jones & Carter, 2007; Richardson & Liang, 2008). Consequently, teachers' implied that their self-confidence in teaching science developed as they learned along with their students, or had supplemental resources such as AMSTI materials, which helped in providing inquiry-based instruction. All teachers from Rosebud Elementary

indicated that they felt more confident in teaching science than in years past, while all but one teacher from Jefferson Elementary expressed less confidence in their science teaching, due to a lack of resources or the need to build on their background knowledge in science. Jones and Carter's (2007) research is also supported, in that self-efficacy and teacher confidence contributes to effective science teaching.

Implications

In addressing the previously stated research questions, this study identified ideal knowledge, skills, and dispositions for elementary science teachers from the perspective of elementary science teacher educators, elementary principals, and elementary science teachers: (1) a willingness to learn/open-mindedness; (2) having content knowledge; (3) having planning, organization, and preparation skills; (4) recognizing the importance of teaching science; and (5) being aware of various assessment strategies. Much of this information aligns with INTASC's (2002) standards of knowledge, skills, and dispositions for beginning science teachers. They also support portions of NSTA's official position statement on elementary science education (2002). The researcher will now discuss how the study's findings can be used to add to elementary science education program improvement and teacher development.

The findings from this study add to current research which identifies knowledge, skills, and dispositions for elementary science teachers, in that it acquired the perceptions of elementary science teachers, their principals, and science teacher educators in a PDS-type relationship (Roberts, Henson, Tharp, and Moreno, 2001; Feters, Czerniak, Fish, & Shawberry, 2002; Jarvis & Pell, 2004; Mulholland & Wallace, 2005). Science teacher knowledge, skills, and dispositions, and their relation to teacher effectiveness, should be openly discussed among all three groups to

foster congruence and an understanding of all perspectives from school and university settings. These discussions are important, since beliefs influence practice (Hammerman, 2006). The findings from this study also call for communication in clarifying what is expected from elementary science teachers among all educators involved in their formation and work. NSTA (2002; 2003) and INTASC (2002) communicate expectations of elementary science teachers, by providing characteristics and standards for educators. This information must be familiar to all elementary teachers of science, as well as to educators that are directly associated with them (principals and science teacher educators). Educators and future educators can familiarize themselves with the aforementioned standards by presenting and discussing this pertinent information during professional development courses and faculty/grade level meetings in the elementary school setting, and elementary science methods courses during teacher preparation in the university setting.

The study identified common knowledge, skills, and dispositions provided by elementary science teachers, principals, and science teacher educators. These commonalities imply that the educational constituents are in agreement, at least in the areas provided, on the ideal knowledge, skills, and dispositions that are needed for effective elementary science teachers. Educators also spoke positively about the AMSTI program in their schools. This suggests that the AMSTI program has had a positive impact on the teachers and principals alike, and has been positively received by the schools involved in the study.

Some of the elementary teachers shared the desire to obtain more scientific content knowledge. The feeling of non-confidence in scientific content knowledge by teachers is supported by previous literature (Appleton & Kindt, 2002). To increase content knowledge within this PDS model, science teacher educators must work within schools and with teachers

and principals to provide professional development in learning new content in support of the AMSTI material. Professional development courses should be held within the school building to provide convenience for comfort for teachers.

Participants of the study stated that planning, preparing, and organizing were also essential for effective science instruction. To assist teachers with planning, administrators must ensure that teachers have adequate time to prepare to teach science within their classrooms. The researcher suggests that teachers of the study take part in collaborative planning for science to meet the needs of all students within the classroom. Collaborative planning will decrease time constraints and paperwork for teachers and allow more time for effectiveness (Thousand, Villa, & Nevin, 2006).

Elementary teachers of science, principals, and science teacher educators voiced the importance of teaching science within the elementary school. Within this PDS relationship, to ensure that these sentiments resonated with all schools and educators involved in the PDS, administrators should vocally support the teaching of science within teachers' daily schedules. For those principals who are less reluctant to change, the researcher suggests using an interdisciplinary approach. Science can be integrated with other subjects that are deemed more significant because of high-stakes testing, such as language arts or mathematics (Akerson, 2001). The researcher proposes that the teaching of science within elementary schools will become increasingly important as it becomes increasingly significant in high-stakes testing (Pringle & Martin, 2005).

Lastly, educators of the study were cognizant of the need for various types of assessment in elementary science instruction. The researcher encourages educators in this study to continue to use both informal and formal types of assessment. Professional development should be

provided to support teachers in their use of the appropriate type of assessments during science instruction with AMSTI materials. An emphasis on formative and embedded types of assessment within the authentic contexts of doing science should also be a focus of professional development (INTASC, 2002; Klassen, 2006).

Interestingly, as previously mentioned, many of the responses in this study of the teachers and professors seemed to support each other on the knowledge, skills, and dispositions needed to be effective elementary science teachers. Their responses to the guided interview questions were similar on many more questions than the responses of the principals in the study. This disconnection between teachers and principals, although they work in the same schools, and the disconnection between educators and principals, although they work together, will be discussed in detail in the following chapter.

CHAPTER FOUR
ARE ADMINISTRATORS DISCONNECTED?
A COMPARISON CASE STUDY OF
IMPORTANT TEACHER KNOWLEDGE, SKILLS, AND DISPOSITIONS
IN ELEMENTARY SCIENCE

Introduction

Teacher Dispositions

The identification of dispositions as a gauge for teacher effectiveness has become a part of many school systems and teacher education programs. Accrediting agencies, such as the National Council for Accreditation of Teacher Education (NCATE) and the Interstate New Teacher Assessment and Support Consortium (INTASC), have been instrumental in emphasizing teacher dispositions' presence in higher education institutions and local schools. NCATE defines dispositions as: "Values, commitments, and professional ethics that influence behaviors toward students, families, colleagues, and communities and affect student learning, motivation, and development as well as the educator's own professional growth" (2006, p. 53). NCATE and INTASC strongly suggest that teachers have certain dispositions to allow for teacher effectiveness (Smith, Knopp, Skarbek, & Rushton, 2005; Thornton, 2006; Koeppen & Davison-Jenkins, 2007). Administrators' view of teacher dispositions is valuable as well. They will need to assess teachers' dispositions to determine the effectiveness of instruction and their attitude

towards the teaching profession.

In 1992, INTASC generated specific standards (knowledge, skills, and dispositions) that teachers should have upon beginning the profession. This list of principles and knowledge, skills, and dispositions was designed by twenty-five educators, including teachers and representatives from education agencies. INTASC's dispositions include:

- Understanding of concepts, inquiry, and discipline
- Understanding of child development and learning
- Use of differentiated learning and instruction
- Understanding and use of various instructional strategies to develop critical thinking, problem solving, and performance skills
- Individual and group motivation of students
- Use of verbal, nonverbal, and media communication techniques
- Use of instructional planning based on content, students, community, and curriculum goals
- Use of formal and informal assessment strategies
- Being a reflective practitioner
- Maintenance of healthy relationships with educational constituents for the sake of the student.

These attributes would allow teachers to best prepare their students for those skills needed to function in the 21st century (INTASC, 1992).

Because of NCATE's use of teacher dispositions in accreditation, teacher education programs have utilized them in collegiate courses and for professional development, respectively. NCATE clearly states that teachers should have dispositions of fairness and the

belief that all students can learn. Additionally, NCATE strongly suggests that INTASC be referred to for the identification of specific dispositions that beginning teachers should have upon beginning the profession (NCATE, 2006). Since then, a number of studies have been conducted to support INTASC and NCATE in the use and significance of teacher dispositions as factors in teaching effectiveness (Thompson, Ransdell, & Rousseau, 2005; Edwards & Edick, 2006).

The assessment of teacher dispositions within evaluation systems for continued employment falls to school systems and their administration and principals. Teacher dispositions help determine teacher effectiveness in the classroom (Taylor & Wasicsko, 2000). Therefore, principals can use this information to predict and determine effectiveness of teachers. In a study conducted by Thompson, Ransdell, and Rousseau (2005), the researchers decided to observe elementary teachers that were deemed effective by their principals. Effectiveness was determined by students' scores on standardized tests and by principals' own individualized criteria (which was not identified in the study). The dispositions of fourteen elementary teachers were investigated, by comparing their dispositions to the INTASC standards for beginning teachers. Teachers were found to communicate well, but preferred to use direct instruction as opposed to various instructional techniques. The researchers confirmed the thoughts of the principals, in that they also concluded that the teacher participants displayed dispositions of effective teachers (Thompson, Ransdell, & Rousseau, 2005).

Since it has been established that teacher quality and effectiveness is of such importance, it is imperative that teacher dispositions, as well as knowledge and skills, are further studied. Teacher knowledge, skills, and dispositions should also be studied under a narrower focus, by studying them in the various content areas. This study calls for the attention of teacher knowledge, skills, and dispositions in the area of elementary science. By studying and focusing

on elementary science teacher knowledge, skills, and dispositions, educators associated with the elementary setting may collaborate and foster teacher effectiveness in science teaching.

Professional Development Schools and Teacher Dispositions

In discussing the need for collaboration on teacher dispositions among elementary schools and colleges and universities, one must consider the importance of The Professional Development School (PDS). The PDS is intended to create working and close relationships between education faculty and local schools. According to NCATE, “Professional development schools are innovative institutions formed through partnerships between professional education programs and P–12 schools. Their mission is professional preparation of candidates, faculty development, inquiry directed at the improvement of practice, and enhanced student learning” (2001, p.1). Professors and their students are visible in surroundings schools, as research, collaboration, and open communication are key and essential to the success of the PDS. The central purpose is to improve the teaching practice (Darling-Hammond, 2005; Marlow, Kyed, & Connors, 2005; Ridley, Hurwitz, Hackett, & Miller, 2005; Castle, Fox, & Souder, 2006). However, educational constituents’ attempt to achieve this purpose or objective has not been unproblematic. Colburn (2003) notes that institutions and schools have different goals with different cultures; this causes difficulty in finding PDS models that effectively display effective teaching, training, professional development, and research. Colburn likens the PDS to a hospital; the PDS unifies teachers, preteachers, and professors, in the way that a hospital brings together doctors, future doctors, and researchers (2003). All participants of the Professional Development School should benefit as a result of taking part (Marlow et al., 2005).

The PDS partnership has shown great promise in improving both student achievement and teaching dispositions. In Bell’s (2002) study of a PDS elementary science partnership and

the National Science Education Standards (National Research Council, 1996), the researcher hypothesized that the PDS model, tied with the National Science Education Standards, would help to improve science education and elementary science teaching. With an emphasis on teaching science through inquiry, inservice teachers' science beliefs and attitudes were increased as a result of being involved in the PDS. Like preservice teachers, they also showed significant gains in learning when actively engage in inquiry-based teaching (Bell, 2002).

Specifically, this study focuses on the perspectives of practicing teachers, principals, and professors of elementary science education in a Professional Development School arrangement on essential knowledge, skills, and dispositions needed for effective science instruction. The following questions guide the study: (1) How do elementary principals in this local case study view effective knowledge, skills, and dispositions for elementary teachers who teach science? and (2) How do these knowledge, skills, and dispositions differ from what elementary teachers have learned from their university-based learning and what science teacher educators feel are needed for effective elementary science teaching? A discussion of related literature, methods, data analysis, results, followed by implications for further study, will now be discussed.

Literature Review

Elementary Science Teacher Knowledge, Skills, and Dispositions

In 2002, the National Science Teachers Association (NSTA) put forth their official statement on effective elementary science teaching. In their statement, inquiry-based instruction and learning is placed at the forefront as part of the daily curriculum. Teachers are also expected to prepare students to be problem-solvers in a society of science and technology. Additionally, NSTA (2003) created a number of standards for candidates preparing to teach K-12 science.

These standards were based on previous research and the National Science Education Standards (1996), the framework for teacher preparation in science instruction, and provide guidance in ideal dispositions for effective science teachers. The goal of these standards is for teachers to lead students to becoming scientifically literate, understanding the subject of science and use problem-solving skills when investigating information. NSTA also encourages teacher education programs to use these standards as a foundation for assessing preservice teachers' performance in science instruction (2003).

Pedagogical content knowledge and scientific inquiry are two topics that are associated with the effectiveness of elementary science teaching, and relate to this study. The NSTA's stance is for elementary teachers to be involved in professional development that will build their pedagogical content knowledge for teaching science (2002). Also, from a national perspective, the National Science Education Standards state, that through professional development, future and practicing teachers must be afforded with experiences that help them build their understanding of science content knowledge (National Research Council, 1996). The NSTA simply states that science inquiry must be a daily part of students' schedules (2002). This statement rests on the belief that children learn best when they are guided to use inquiry and process skills in science, as well as being provided with opportunities to explore and investigate. The NSTA (2002) also asserts that students value science instruction when elementary teachers model inquiry-based learning for their students. They suggest that the learning cycle be used to teach exploration and questioning strategies in scientific inquiry (NSTA, 2004).

In relation, INTASC has created a list of standards that include knowledge, skills, and dispositions for beginning K-12 science teachers. The standards provided are different than the previously mentioned standards, in that they are specific to the subject of science. These

standards, in INTASC's opinion, will promote scientific inquiry and student learning within science classrooms (2002). The standards include: content knowledge; student learning and development; student diversity; instructional variety; learning environment; communication; curriculum decisions; assessment; reflective practitioners; and community membership (INTASC, 2002). Because of their specificity in nature, the knowledge, skills, and dispositions provided by INTASC were used to analyze this study.

Administrators' Role in the Teaching of Science

This study also takes into consideration perspectives of elementary principals on elementary science teacher knowledge, skills, and dispositions. Teachers have recently repeatedly vocalized the fact that science instruction is limited within their classrooms, due to continued emphasis on reading and mathematics and high stakes testing (Griffith & Scharmann, 2008). There are few studies regarding elementary administrators' positions on science teacher knowledge, skills, and dispositions. However, a few works or studies discuss administrators' role in the delivery of science education (Spillane, Diamond, Walker, Halverson, & Jita; 2001; Lewthwaite, 2004).

When delivering science instruction, elementary teachers often have a feeling of inadequacy in teaching the subject, and often "think of science as a body of knowledge" (Eiss, 1962, p. 171). These feelings of inadequacy cause teachers to be reluctant to teach science, and if administrators can find ways help these teachers, these same teachers can become advocates of science programming within their schools (Eiss, 1962). Eiss also proposes that principals provide professional development in science and appoint a science supervisor or specialist, who could easily be a classroom teacher already employed at the school. Eiss stresses the need for cooperation from administrators to ensure a high-quality elementary science program (1962).

Adding to previous research, the NSTA published a series of handbooks on administrators and elementary science education (1983). The handbooks, entitled “Promoting Science Among Elementary School Principals,” sought to provide principals with methods for identifying and maintaining effective elementary science programs within their schools (Mechling & Oliver, 1983). Administrators were provided with a checklist for the purpose of assessing their science program, and as a means for providing goals for administrators to work toward. The authors were innovative in that they focused solely on providing principals with sound advice and methods for successful science education programming.

NSTA also provided guidelines for administrators’ role in elementary science education (2002). In their statement of elementary science education, they assert that administrators must become active supporters of science instruction within their schools and become instructional leaders by ensuring that programs are based on national and state standards and examining the programs’ success. Administrators must form a support system for science programs, by providing resources for science instruction, noting that excel in science teaching, and promoting science events within the school (NSTA, 2002).

Current studies center on not only elementary science teachers, but also those that work closely with them or those that can affect them (Darling-Hammond & Sato, 2006; Klentschy & Maruca, 2006; Saginor, 2006). These studies echo the sentiments of Mechling and Oliver (1983): Science education reform in the schools is more likely with the support of the building principal. Specifically, Saginor states that the principal as leader must:

[M]anage the culture of change and build professional learning communities; cultivate teacher-leadership; advocate for science to be taught in elementary school to support literacy; provide for proper professional development; understand standards-based

science so when he or she knows what to look for when observing a class; [and] have tools to supervise teachers in the best instructional practices for producing enduring learning and deep content in science. (2006, pp. 164-165)

Lewthwaite observed that teachers were uncomfortable with their principal's role in science instruction (2004). Teachers and administrators agreed to work together to improve science programming within their elementary school. Although teachers are ultimately responsible for delivering instruction within their classrooms, principals are held accountable for professional development, mentoring, and ensuring that their teachers meet the high standards that educators often expect from their students (Darling-Hammond & Sato, 2006; Saginor, 2006).

Principals are essential to the success of the elementary school. They bridge the gap between teachers, parents, community members, and higher education institutions. In the area of elementary science teacher knowledge, skills, and dispositions, their role is also vital. Administrators directly and indirectly affect the change or development of teachers' dispositions regarding science instruction, and must frequently make most of the decisions in their schools. These choices can often shape the knowledge, skills, and dispositions of the school's elementary science teachers.

Participants and Context

The participants consisted of eight elementary science teachers and their two principals of a small southeastern school district in close proximity to a land-grant university with a large teacher education college. Two schools (Jefferson Elementary and Rosebud Elementary) represented the participating school district. As mentioned in the previous chapter, these elementary schools were chosen because of the close relationship that was formed between the

school system and the university. Science education instructors from a large southeastern university also participated. The science teacher educators that participated were tied to the teachers and principals based on a Professional Development School (PDS) program, in which the professors were often visible within the schools. (For confidentiality purposes, pseudonyms have been used for participants' names and the names of their schools.)

Teachers

Eight elementary science teachers from two separate elementary schools participated in the study. Teachers taught grades three through five. Five teachers took part in the study from Jefferson Elementary, and three teachers participated from Rosebud Elementary (See Table 5). These teachers were selected with the understanding that science was being taught on a regular basis. All teachers have self-contained classrooms; they teach and are responsible for the same students for the entire day. Jefferson Elementary teachers have been in the profession from one to eleven years. Rosebud Elementary teachers have taught seven to twelve years.

Table 5 – This table represents teacher participant descriptive data.

Teacher Participants

Teacher	School	Grade Level Taught	Number of Years Teaching Science
B. Elsner	Jefferson Elementary	3rd	1
R. Davis	Jefferson Elementary	5th	11
L. Karwoski	Jefferson Elementary	4th	2
D. Gardner	Jefferson Elementary	3rd	2
M. Malone	Jefferson Elementary	3rd	4
T. McDowell	Rosebud Elementary	5th	11
J. Holston	Rosebud Elementary	5th	12
A. Douglas	Rosebud Elementary	4th	7

Principals

The schools in this school system are unique in that they only have head principals, and no assistant principals. Dr. Chappell, the principal of Rosebud Elementary, taught fourth grade science for six years before becoming an administrator, and was in his eighth year of being a principal at the time of the study. He taught science twice a day, in addition to teaching math and history each day. The principal of Jefferson Elementary, Mr. Daniels, taught science and reading for two years within a departmentalized, middle school setting. He has been a principal for five years. While teaching science, he equated his teaching effectiveness to whether students had a clear understanding of the purpose of the activity being conducted.

Science Teacher Educators

The professors, Dr. Miller and Dr. Scott, are the sole faculty members that teach science education courses to elementary science majors at the university. Dr. Miller began teaching

secondary science methods courses (for seven years) before moving on to teaching elementary science methods courses for three years. He taught for approximately ten years, in middle and high school settings, before becoming a science teacher educator. Dr. Scott has taught elementary science methods courses for six years. Before becoming a science teacher educator, she taught fifth grade science for four years and taught elementary students through the National Aeronautics and Space Administration (NASA).

Relationship of Participants

The schools and college in this study interact with each other on a consistent basis, based on their PDS-type relationship. The schools are both used for elementary intern placements from the college, as well as laboratory placements during methods courses. The schools, Jefferson Elementary and Rosebud Elementary, are both considered intermediate schools since their grade levels range from three to five. Each teacher instructs students in self-contained classrooms, and science is taught on a daily basis, although some admit to not being to always teach it daily. The amount set aside for science instruction ranges from 30 to 45 minutes long. Teachers conduct lessons according to their state's course of study, including materials funded by the Alabama Math, Science, and Technology Initiative (AMSTI). AMSTI (2009) utilizes research- and inquiry-based curriculum designed to improve mathematics and science instruction. Kits are the basis of the curriculum, such as the Full Option Science System™ (FOSS) and Science and Technology for Children™ (STC) programs. After principals agree to enroll their school in the AMSTI program, teachers and administrators attend training. Teachers receive an additional 120 contact hours before completion; administrators' training is less than that of teachers, and the amount of training they receive is not specified. The AMSTI program also requires participating schools to work closely with a neighboring college or university (2009).

Methods

Data Sources

After gaining consent from participants, the researcher conducted individual or focus group interviews to collect data regarding elementary science teacher attitudes and opinions of elementary science teacher dispositions. Individual face-to-face interviews were conducted for the principals and science teacher educators. The researcher chose to conduct focus group interviews with the elementary science teacher participants. Utilizing focus groups can help to incite emotions and spontaneity about the topic at hand (Kvale, 1996). A list of guiding interview questions was utilized for each interview (See Appendix). The participants answered questions relating to their science teaching experience, the length of time dedicated to science instruction, and beliefs about ideal elementary science teacher dispositions.

A number of artifacts were collected as well. According to Schwandt, “An artifact is an object that carries meaning about the culture of its creators and users. Understanding and interpreting the composition, historical circumstances, function, purpose, and so on of artifacts are central to the study of material culture” (2007, p. 9). Elementary science teachers were also asked to submit lesson plans to supplement the study. Each teacher was asked to choose and submit a lesson that represented their most effective science lesson. Science teacher educators were asked to submit syllabi for their science elementary methods courses. These items were used to provide triangulation for their thoughts and perspectives of elementary science teacher dispositions (Schwandt, 2007). A personal researcher journal was also kept, by the researcher, to record thoughts and ideas related to implementation of the study. The journal provided a means of personal observations and realizations made during the researcher’s journey, as she conducted

interviews and transcribed and analyzed data. According to Lichtman, a journal helps one self-reflect on his/her thinking and motivation, which affects is affected by research interests (2006).

Data Analysis

The data collected were analyzed across participating schools, and the university, as a multi-site study, and part of a larger case study on elementary science teacher dispositions (Cresswell, 2007; Lichtman, 2006). Cases included teachers and the principals of each school. Individual cases were studied within a bounded system of the local university-teacher education program. Therefore, each school is considered an individual case, along with its relationship with the university, and then studied across cases in comparison to the other elementary school (Creswell, 2007).

One audio-taped focus group interview was conducted with the teachers at each school. This resulted in two total focus group interviews. The researcher also conducted individual audio-taped interviews with each principal and science teacher educator. All interviews (individual or focus group) were transcribed and analyzed in a text document, using the research questions previously stated (Kvale, 1996). The researcher looked for patterns in responses as they related to elementary science teacher knowledge, skills, and dispositions and participants' attitudes and beliefs towards science instruction, and coded these in categories. For example, after reading participants' responses that related to materials and delivery of instruction, having a lack of resources and hands-on science were two topics that stood out immediately to the researcher, and became the titles of categories for participants' responses.

Responses were coded based on commonalities that were then noted as emerging themes. The noted themes became evident during the initial and second coding processes. For example, themes of hands-on science, inquiry, exploration, and discovery emerged as educators discussed

the best approaches to teaching science. Themes were recorded in a text document using word processing software. These themes were compared and contrasted as they became evident to the researcher (Coffey & Atkinson, 1996; Creswell, 2007; Schwandt, 2007). In the within-case analysis, commonalities were noted within each school or case (e.g., Jefferson Elementary vs. Rosebud Elementary). Next, in utilizing a cross-case study analysis, commonalities were noted by looking at both schools, or across cases (e.g., Jefferson Elementary and Rosebud Elementary) (Creswell, 2007). Topics and dispositions identified by teachers and science teacher educators were also compared to their corresponding artifacts (lesson plans or syllabi), to corroborate participants' responses.

Interestingly, during this overall process, the researcher noticed that principals were responding differently than teacher and science teacher educator participants, in many instances. As emerging themes became evident, the researcher created a table or matrix to help interpret and provide a visual representation of these findings (Yin, 2003). The matrix noted the responses that principals gave, in comparison with the teachers and science teacher educators, to the questions asked during the individual and focus interviews. This particular chapter discusses principals' responses, in contrast with the other educators, and what was noticed after the original study was conducted. The results represent those responses and differences that were most evident to the researcher. Evidence of participants' thoughts and ideas are provided through excerpts from interviews, along with interpretations made by the researcher.

Results

The elementary teachers and science teacher educators were in agreement on what was most important for the knowledge, skills, and dispositions of elementary science teachers.

However, the principals did not vocalize many of the same knowledge, skills, or dispositions as the other two groups of educators. Principals responded differently to the questions being asked in the study, although all participants were asked the same or similar questions at the time of their interviews. Table 6 shows the themes emergent in this study on the interview questions asked for principals, elementary teachers, and science teacher educators. The table was created to provide a visual representation of the findings that emerged in the study. Teacher and science teacher educator responses are labeled together, since they're responses were similar in nature.

Table 6 – This table displays the themes emergent from principals and other participants on key interview questions.

Emergent Themes from Interview Questions

Interview Question Being Addressed	Principals' Responses	Teachers and Science Teacher Educators' Responses
Self-Evaluation of Teacher Effectiveness	<ul style="list-style-type: none"> • Enjoyment • Refined Practice 	<ul style="list-style-type: none"> • Content Knowledge
Value of Teaching Science	<ul style="list-style-type: none"> • Experiments • Hands-on Science 	<ul style="list-style-type: none"> • Real-Life Applications • Student Connections
Best Approach to Teaching Science	<ul style="list-style-type: none"> • Hands-on Science 	<ul style="list-style-type: none"> • Scientific Inquiry • Exploration/Discovery
Lesson Planning	<ul style="list-style-type: none"> • Lack of Resources 	<ul style="list-style-type: none"> • Planning for Instruction

Delivery of Instruction versus Content Learning

One of the interview questions asked principals if they felt as if they were effective when they taught science, while elementary teachers and science teacher educators were asked if they thought that they were effective in their current positions. The two principals responded differently than the other educators, and responded differently when compared to each other as well, although their responses related to delivery of instruction. Mr. Daniels equated his teaching

effectiveness to being able to improve his delivery of instruction from year to year, and being able to conduct experiments with his students. On the other hand, Dr. Chappell shared that he thought that he was effective because he was able to enjoy the material as he delivered science instruction. He also stated that he was ineffective at times, due to not having the proper resources to be effective while teaching science.

Pretty much...ah...I think I was okay! I was always willing to improve from different experiments that we had done from one year to the next year, and looking at ways at trying to reach the students to make sure that they were having a clear understanding of the purpose of the different experiments and why we were doing them. [Daniels, Principal, Jefferson]

I think that I would say yes I was [effective], but it's *because* of the fact that I enjoyed it so much. You know science, and *especially*...you know, in areas like the weather and the earth and that kind of stuff. Um...but then again, I'm saying probably not because of what I just said about the limitations of...of resources. But, because I enjoyed it so much though, I...I would lean more towards the yes side. [Chappell, Principal, Rosebud]

In contrast, teachers and science teacher educators mentioned the need for content knowledge for teacher effectiveness. Content knowledge was noted by both groups of educators as a necessity for effectiveness in teaching elementary science.

I learned this year with my kids. I was like...I was learning things this year in science that I don't know that I've ever...I probably was taught at one time, but I don't remember it so, this year I was like, "Oh ok!..Yeah!" You know, "I'm learning something with y'all!" [Douglas, Teacher, Rosebud]

Professors provided support for content knowledge in their syllabi for their science methods courses. Dr. Scott's course description stated that preservice students would be introduced to content that would be needed to teach in their own classrooms. In Dr. Miller's syllabus, the course description states that the course:

Was designed to assist prospective teachers in developing the confidence and competence needed to begin teaching science as a hands-on, process approach in elementary classrooms. This competence involves a basic level of understanding of the subject matter and the inquiry nature of 'doing' and learning science...

Of the course objectives, one states that students will be able to develop competency and an enjoyment of science instruction as a result of being in the course. Dr. Miller also utilized reflective journals in the course, so that students could make the necessary connections with what was being learned as they taught and observed in the cooperating teachers' classrooms.

Hands-On Science versus Connections to Life and Academic Success

Participants were also asked what they valued about teaching science as a subject. When principals responded, they both stated that they enjoyed administering hands-on science instruction, or teaching science using experiments. They also added that the textbook should be used as a supplementary resource. Interestingly, Dr. Chappell again mentions the lack of resources having a negative effect on science instruction.

I liked the fact of having...hosting experiments and having like a hands-on science in the classroom along with the textbook as a reference. [Daniels, Principal, Jefferson]

Well, I enjoyed it! Now, the only thing was, there were limitations because, we were kind of...we were very much limited to the textbook, which I don't think is good...So, on those few rare occasions where we could actually do some kind of experiment or

something like that...*those* were the ones that I really valued and the ones I think that the students valued as well! Where they were able to actually do something and see something and experience something, but just being tied to the book though made it difficult. [Chappell, Principal, Rosebud]

On the other hand, elementary teachers and science teacher educators responded differently than the principals, but similar to each other. Being able to relate science to everyday life and providing a foundation for further study was mentioned as a skill needed for elementary science teachers. The following excerpt is representative of teachers' and elementary science teacher educators' response being asked what they value about teaching science as a subject. Dr. Scott states:

One of the things that I value is that I understand, and I want my students to understand that yes science is a content class, but it also offers so many other things in helping you deal with real-life situations and real-life application. There's problem-solving. You know we have to problem-solve and do things every day, and one of the statements I make to *my* class is that, "We're *all* scientists." Because every day we make observations, we do investigations, we experiment, we collect like data...So that's really important to me, to be able to use science as a vehicle for being able to operate in the everyday world.

[Scott, Professor]

In regard to applying instruction to everyday life for students, teachers and science teacher educators were aware of the need for this skill for elementary science teachers. Teachers recognized that many of their students need to understand the importance and reasoning behind learning about science. The teachers made connections in their instruction to address these needs, and also wanted to provide a foundation for higher grade levels. In her submission of "Lifeboats

Investigation” as one her most effective lesson plans, Ms. McDowell, of Rosebud Elementary, stated that she originally chose the lesson because it prepared them for higher-level sciences. Ms. Holston, also of Rosebud Elementary, enjoyed her lesson on observing microscopic worlds because it provided a closer look into students’ worlds. Ms. Davis, of Jefferson Elementary added, “I value it because in fifth grade, the kids are starting to understand that they can take this into the future that their jobs in the future will have, will be related to what they are doing now.” In the collegiate setting, Dr. Miller notes that throughout the semester, preservice teachers would gain practice teaching and learning in an everyday atmosphere.

Simply Hands-On versus Inquiry and Discovery

Teachers utilize various methods to dispense learning within their classrooms. In terms of instruction, teachers and science teacher educators referred to inquiry-based instruction and using exploration and discovery in their teacher methods. Principals, on the other hand, simply emphasized a hands-on approach to help reinforce learning in a way different from simply traditional teaching methods.

Hands-on Science

When asked how students learn best, both principals participating in the study responded differently than their counterparts. However, they responded similarly to each other. Instead of referring to inquiry, discovery, or exploration in teaching as an elementary science skill or dispositions they discussed the importance hands-on science within classrooms.

My beliefs is that students should be at least introduced to the opportunity of learning science in a different manner...to where it’s either hands-on or having enough resources in the classroom to where it addresses some of the things that they’re interested in, as far

as their prior...or prior knowledge about different objectives that they have to cover each year at each grade level. [Daniels, Principal, Jefferson]

[To] me they learn it when they're actually doing it. So, I mean it keeps coming back to that same thing over and over, and that is the theme of actually being able to *do* some things with their hands and not just sit there with the textbook and look at a few pictures. You know that...that's *good* and has its place, but...you know if they can actually be doing something, they'll get a whole lot more out of it. And it sticks with them, too.

[Chappell, Principal, Rosebud]

Hands-on science is preferred instead of textbook-related activities. Mr. Daniels also makes mention of the need for resources and alludes to science instruction being effective when students' prior knowledge is activated. They responded differently, when compared to the other participants, to being asked how students learn science best.

Inquiry

The following response includes an answer representative of teachers and science teacher educators being questioned about perspectives of the best teaching methods for science and how students learn science best.

My approach is to first build my background knowledge of what I'm teaching and then to think of a way to introduce the topic at hand that gets my students using the scientific process or method. I think of an activity in which they are able to build inquiry upon and then I introduced the vocabulary and or facts. [Elsner, Teacher, Jefferson]

The use of inquiry-based teaching can also be categorized under instructional variety as a fundamental elementary science teacher disposition. The teachers and education faculty discussed inquiry as the best, or one of the best, approaches to teaching effectiveness. In her

lesson plan on matter, Ms. Elsner's students took part in observations and questioning practices. She stated that she created and chose this particular lesson plan because it allowed students to participate in scientific inquiry. In the course syllabus for the elementary science methods course, Dr. Scott simply asserts that the students will explore inquiry-based planning and teaching practices. Course periods were devoted to discussing the meaning of inquiry, inquiry process skills, and inquiry-related assessment. Dr. Miller required preservice students to use resources that tie inquiry to children's literature. Students learned about the nature of doing science as it relates to inquiry, and modeling and practicing inquiry-based teaching. It is also interesting to note that inquiry is the only topic or disposition mentioned here that is not mentioned by teachers from both schools; only teachers from Jefferson Elementary and the science teacher educators discuss inquiry in science.

Exploration and Discovery

In addition to inquiry-based learning, science teacher educators and teachers of the study agree that students should take part in exploration and discovery to reach their highest learning potential. Again, the following excerpt is a teacher response to how students learn science best.

I think they learn through like, actually discovering. Like, you can't tell a child that if you plant a seed it's gonna grow some roots, and then it's gonna grow into a plant with a flower, and then the process starts...[Growing a plant] might take a month...but over time, they're going to remember and retain information more because they actually saw it and used it...I think they learn better by actually discovering...So I think allowing them to take some responsibility and learn on their own helps them actually see it. [Karwoski, Teacher, Jefferson]

Ms. Karwoski, of Jefferson Elementary, submitted a lesson plan on animals and how their characteristics help them adapt to their environment. In her reasoning behind choosing the lesson plan, she stated that she chose the lesson because students could discover science instead of simply being taught science. Dr. Scott has time set aside in the course to discuss discovery learning's impact on students. Dr. Miller, a science teacher educator, predicted that elementary teachers would mention dispositional qualities related to exploration, hands-on science, and investigations. Interestingly, his response was a mixture between teacher and administrator responses.

Resources for Teaching versus Lesson Planning

In discussing planning, organization, and preparation for science teaching, both principals note that having a lack of resources can negatively impact lesson planning and science instruction in the elementary classroom. In the following responses, administrators state how they think teachers will respond to being asked what dispositions are needed to be effective.

The fact of having adequate resources to be able to host the different types of hands-on science experiments in a regular classroom and making sure you have enough for all the students that are within that classroom. [Daniels, Principal, Jefferson]

I think most of them would probably say the same thing. It's just that it goes back, though, to so many times having limitations on your resources. And of course you know, now next year they're saying that it's not going to be...we're going to be real short on funds. Well, that's going to be tough! Because, you know, you don't really expect your teachers to go out and spend his or her money on all of these supplies, even though I know some do! But...but I think when it gets down to it though, I think that most of them

would have that same feeling that I do that it's best to not be limited to that textbook.

[Chappell, Principal, Rosebud]

Dr. Chappell also predicts that teachers will state that being limited to the textbook for instructional practice will limit them in terms of effectiveness, and includes funding as well as materials in terms of resources for science programming.

Lastly, teachers and education faculty stated that elementary science teachers must set time aside to plan, organize, and prepare for lesson planning in order for science teaching to be effective. Ms. Karwoski admitted that she has learned from not taking time to plan ahead for science lessons.

I think you have to plan ahead, which is really hard for me a lot of times because we do have so many other things going on that it's like, oh, I have this great idea, but [I] haven't planned it so it doesn't turn out exactly like I would have wanted it to...so I feel like you have to be able to plan in advance and try things before your students try them.

[Karwoski, Teacher, Jefferson]

Dr. Miller, a science teacher educator, adds that elementary science teachers must be able to plan ahead of time what should be taught.

There has to be some sense of a system or organization inside that person that enables them to plan and prepare and lay out what needs to be taught...especially as a new teacher. If you can't do that, it's *rare* that you're going to be able to wing it without experience as a brand new teacher. So I think that's important. [Miller, Professor]

In his syllabus, Dr. Miller notes that preservice students will learn how to plan effectively for science instruction. Time is provided in the course to prepare for their co-teaching assignments.

Two lesson plans are submitted in the course. Dr. Scott ties in technology with lesson planning in

her elementary science methods course. Time is also given, within the course, for learning how to plan and manage science instruction within the elementary classrooms. Three lesson plans are submitted before ending the course.

Discussion

Participants of the study responded to questions addressing: self-evaluation of teacher effectiveness; the value of teaching science as a subject; how students learn science best; and lesson planning. Principals responded differently than teachers and science teacher educators, when questioned. They identified the need for experiments and hands-on science, with the textbook as a supplementary resource, as significant in elementary science instruction. They also mentioned that a lack of resources or funding negatively affects lesson planning and limits teaching effectiveness. Although principals taught science more than or equal to some of the teachers, teachers and science teacher educators responded differently.

On the other hand, elementary science teachers and science education faculty identified different teacher knowledge, skills, and dispositions for effective science teaching. These included: content knowledge; real life applications/student connections; inquiry; exploration and discovery in learning; and the ability to effectively plan for science instruction. All of these teacher topics relate to INTASC's standards (knowledge, skills, and dispositions) for beginning science teachers (2002). The INTASC standards are: content; student learning and development; and instructional variety. The findings identified by principals, teachers, and science teacher educators will now be discussed.

Adequate resources contribute to teachers being able to teach science effectively, and administrators must support teachers by providing materials and equipment for science

instruction (Mechling & Oliver, 1983b; Lewthwaite, 2004). Principals equated their teaching effectiveness on being able to improve their teaching practices and on their availability of resources within the classroom. This may be attributed to science teachers historically not having an adequate amount of resources, which may have been the situation at the time that these administrators taught, compared to what current teachers have to teach science. Like the teachers in Lewthwaite's study, teachers in this case study did not identify a lack of resources as a contribution to their ineffectiveness (2004). This fact can easily be related to teachers being adequately provided with resources through AMSTI, therefore leading to a greater focus on planning and increasing content knowledge to teach with these materials. According to NSTA (2002), teachers and science teacher educators identify content knowledge as an essential skill or dispositional quality for an effective elementary science teacher. In addition to INTASC's (2002) insistence on content knowledge, NSTA, in its official statement on elementary science teaching, notes that teachers must constantly engage in professional development to increase science content and skills in teaching (2002). Teachers' admittance to a need for increased science content knowledge suggests that teachers adhere to previous literature's assertion that there must be continuous professional development to meet this need (Jarvis & Pell, 2004; Klein, 2005). In support of previous literature, teachers also increased their content knowledge as a result of teaching inquiry-based lessons (Bell, 2002).

In terms of what is valued in teaching science as a subject, principals again mentioned the importance of hands-on science instruction. This supports Nabor's study in which principals stated that they were in support of hands-on science within their schools (1999). Principals also stated that textbooks should be used as a supplementary resource. Teachers and science teacher educators, however, discussed the importance of providing real-life applications of science for

their students. They realized that they must ensure that they provide the foundation for future learning in the subject of science. Thus, students will be prepared for the scientific and technological world that NSTA speaks of in its official statement of elementary science education (2002).

For administrators, the importance of hands-on science within the elementary classroom is vital. Principals believed that hands-on science was the best method for teaching science. Again, this data supports previous research that states that principals encourage and prefer hands-on science within the elementary science classroom (Nabors, 1999). NSTA also advocates that elementary preservice and inservice teachers be involved in hands-on activities during teacher preparation and professional development (2002). Knowledge of scientific inquiry, inquiry-based approaches, and exploration were stated by teachers and professors as essential skills or dispositions for effective elementary science teachers. The National Science Education Standards notes that students must be involved in activities where they are allowed to inquire (National Research Council, 1996; National Academy of Sciences, 2000). In order for this to take place, teachers must understand the concept of inquiry themselves. Teacher and science teacher educator participants also stated that student exploration was a significant part of effective instruction. Further, NSTA maintains that teachers must be able to model inquiry skills for their students, and that students learn best when they are involved in inquiry and exploration (2002). Principals mentioned the use of hands-on science as an instructional method. However, inquiry-based learning has been determined as being more effective for scientific learning (National Research Council, 1996; NSTA, 2002). The statements of differences in approaches, (e.g. hands-on science versus inquiry, exploration, and discovery) may be attributed to the education terminology used at the time each educator was or is in the classroom, combined with keeping

abreast of current research and contemporary practices related to elementary science instruction. The researcher proposes that teachers and science teacher educators remain current through professional development and research, practices that may be less common, but desirable, for principals also (Saginor, 2006).

Lastly, principals, teacher participants and professors discussed the significance of planning, preparation, and organization, and their role in science teaching effectiveness. Principals stated that they thought that a lack of resources would be identified by elementary teachers as a hindrance to lesson planning. Consequently, NSTA states that administrators can contribute to this aspect by ensuring that teachers have the proper materials and resources for science programming (2002), which is also supported by previous literature on science teaching (Lewthwaite, 2004; Saginor, 2006). This suggests that principals can directly influence teachers' ability to plan, prepare, and organize for instruction. In opposition, elementary teachers and science teacher educators stated that effective science teachers have the ability to plan and organize for their lessons. Since AMSTI provided resources for science teaching, teachers' concerns were shifted towards managing their time in terms of lesson planning. Lack of resources was no longer a major issue in lesson planning.

Implications

The findings from this study found that principals have differing views from elementary science teachers and science teacher educators. The findings contribute to current literature that stress the administrator's role in effective elementary science programming (Lewthwaite, 2004). These views were identified and discussed, and can influence science reform and inform science education policy in these school cases in a number of ways.

The gaps in findings between principals and the teachers and science teacher educators in this study do not suggest that one group is less knowledgeable than the other in relation to elementary science programming and views of teacher self-evaluation, the value of science teaching, the best approach to teaching science, and lesson planning in science. Neither do their responses deny the importance of science being taught in the elementary schools involved. However, they do suggest that participants responded differently to the questions being asked. Principals focused on tools and strategies for making science possible and more enjoyable for students, while teachers and science teacher educators focused on academic goals and goals for scientific literacy.

The findings from this study do imply that the necessary amount of communication may not take place in regard to elementary science programming at the participating schools. Science teacher educators are able to disseminate valuable information related to effective science teaching to preservice teachers, as well as inservice teachers, when visiting within schools. Teachers and science teacher educators within this PDS system must openly communicate with principals about what is needed to ensure maximum effectiveness in science programming (Petto, Patrick, & Kessel, 2005). There must be constant sharing of knowledge between all participants from Jefferson Elementary, Rosebud Elementary, and the local university (Fullan, 2002). In this study, hands-on science was frequently discussed by principals, while inquiry teaching was deemed significant by teachers and science teacher educators. Elementary science reform will also call for open discourse among teachers, principals, and science teacher educators about certain terms or areas in science that may be unfamiliar to administrators: discuss the meaning of hands-on science and inquiry, how these words look within the elementary classroom, their differences, and effectiveness (National Academy of Sciences; 2000;

van Zee, 2006). Participants of this study may also discuss, for confirmation and comprehension (if necessary), how to change hands-on science lessons into those that are inquiry-based (Huber & Moore, 2001). The researcher also suggests that there be a true science liaison to improve communication practices between teachers, principals, and science teacher educators within the study, and to serve as a true leader of science (Eiss, 1962; Spillane et al, 2001). This liaison can easily be a classroom teacher or an already existing specialist for AMSTI at each school participating in the program.

Additionally, administrators must continue to realize and maintain the importance of science programming within their schools, and guarantee that teachers receive professional development in science instruction (Mechling & Oliver, 1983b). To address the seemed disconnection between principals and their counterparts (teachers and science teacher educators), principals must take part in science professional development courses that are intended for *their* development in elementary science programming. In this particular PDS relationship, science teacher educators, with the assistance of teachers, may be tapped to work closely with principals to administer professional development that is relevant to principals' needs in relation to elementary science programming, including information on content knowledge and effective teaching approaches (Mechling & Oliver, 1983b). Acquisition of this new knowledge will help to improve communication with all involved in the PDS relationship, and also improve collaboration. Through collaboration, which is the focus of the PDS model, all educators involved will move towards effective elementary science programming, which will ultimately result in science literacy for all students.

CHAPTER FIVE

CONCLUSIONS

Introduction

The study of teacher dispositions has become recently important in teacher education in our nation. The assessment of teacher dispositions can support teacher effectiveness and provide vital information for teacher education programs. Utilizing a qualitative approach, themes emerged as a result of interview questions that were asked to elementary teachers, principals, and science teacher educators. Specifically, this study sought to focus on the teacher dispositions of elementary science teachers utilizing a case study approach. The first part of the study identified common knowledge, skills, and dispositions identified by teachers, principals, and science teacher educators. In the second portion, the researcher discussed the differences in responses that emerged between principals and the teachers and science teacher educators of the study. Ultimately, this study served as a means for providing information that may be used to improve elementary science programming within a working PDS relationship.

Common Knowledge, Skills, and Dispositions

Participants of the study, including elementary science teachers, principals, and science teacher educators identified a common set of knowledge, skills, and dispositions that were, in their professional opinion, necessary for effective science instruction. They included: a willingness to learn, or the ability to be open-minded; possessing content knowledge; being able

to plan, organize, and prepare for lesson planning; being cognizant of the significance of teaching science; and having knowledge of and utilizing various assessment strategies. Each of these topics emerged as themes in the study.

Elementary science teachers that were willing to learn or had an attitude of open-mindedness were perceived as being effective. These attitudes were based on being able to learn alongside students, being flexible, and seeking out ways to continuously learn about effective teaching strategies in science. Specifically, Mr. Daniels, the principal of Jefferson Elementary, asserted that teachings should constantly seek to find ways to improve their methods of teaching in science. Teachers, such as Ms. Douglas of Rosebud Elementary, admitted that they were learning more about the subject of science as they taught their students. They expressed openness to learning new information.

Participants of the study also stated that content knowledge, obtaining information and being able to effectively teach this information to students, is essential for effective elementary teachers. Teachers admittedly stated that they were still building on their content knowledge. In fact, Ms. Elsner, of Jefferson Elementary, discussed that her effectiveness as a science teacher was contingent on being able to build on her background knowledge in science and to be able to effectively teach this information to her students. Dr. Miller, a science teacher educator, revealed that teachers often learn content knowledge prior to instructing students. Science teacher educators supported their claims for content knowledge by devoting time in their elementary science methods courses for the acquisition and application of new content knowledge.

Teachers from both elementary schools and science teacher educators noted that effective elementary science teachers should also be able to plan, organize, and prepare for science instruction. They also realized that planning effectively could positively influence instruction,

while a lack of planning would have the opposite effect. Ms. Gardner, a teacher at Jefferson Elementary, shared that she spends a large amount of time planning for AMSTI lessons, along with a colleague. Science teacher educators devoted time in the course syllabi to helping preservice teachers learn how to plan effectively for teaching science. Dr. Scott, a science teacher educator, discussed planning and managing science instruction, while still integrating technology into lessons.

In addition to planning, educators also stated that elementary science teachers should realize the importance of teaching science within their classrooms. Teachers from one elementary school, a principal from another elementary school, and science teacher educators discussed its significance. Educators noted that the subject of science be deemed as important as other content areas, such as mathematics, language arts, and reading. Along with other teachers, Ms. Douglas, a teacher from Rosebud Elementary, expressed that science as a subject is important because it provides a basis and foundation for higher-level science courses and for careers in the scientific field. Ms. Holston (of Rosebud Elementary), in choosing her most effective lesson, chose a lesson that allowed her students to have a closer look into their everyday world through the use of microscopes. To Dr. Scott, it was pertinent that preservice teachers grasped the realization of science's presence in their everyday world at that they are scientists as well.

Lastly, educators maintained that effective elementary science teachers should also be aware of and utilize various assessment strategies in their instruction. Formative assessment (administered during instruction) and summative assessment (administered after instruction) were both discussed. Teachers, principals, and science teacher educators expressed that both informal and formal types of assessment were needed in elementary science instruction. In

particular, Dr. Chappell, principal of Rosebud Elementary, stated that there is a place for traditional types of assessment (tests and quizzes), but they were more acceptable at the time when he was a student. Teachers stated that they used science journals, observations, conferencing, rubrics, and checklists during instruction to assess students' progress. After instruction, teachers also utilized more traditional types of assessment, such as tests and quizzes, to assess students' knowledge after presenting information. Teachers' submission of their most effective lesson plans reflected the use of various types of assessment. Dr. Miller, a science teacher educator, adds that he stresses to his students of his elementary science methods course the importance of using an array of assessments to determine their future students' comprehension and understanding of the content. Dr. Scott, another science teacher educator, devotes course time towards introducing inquiry-related assessment strategies to preservice teachers.

AMSTI Program

The Alabama Mathematics, Science, and Technology Initiative (AMSTI) was mentioned by representatives from each group of elementary teachers, principals, and science teacher educators. The AMSTI program's focus is to improve science and mathematics instruction in Alabama schools. After principals agree to participate in the program, teachers and administrators participate in professional development courses to prepare them for utilizing AMSTI in their schools. Teachers were required to have 120 contact hours in professional development. After completion, teachers could use AMSTI kits, which included lesson plans and materials for science instruction. Specialists were located at each school as a resource for teachers.

During their individual or focus group interviews, educators stated how beneficial the AMSTI program had become to their elementary science programming. In relation to the knowledge, skills, and dispositions mentioned by educators, teachers mentioned that they were more willing to learn and had learned due to utilizing AMSTI kits. In relation to planning, teachers from both elementary schools also mentioned how AMSTI kits helped them plan for teaching science. One teacher from Jefferson Elementary, Ms. Gardner, mentioned how she plans for science lessons using the AMSTI kits; she often meets with one of her colleagues to go through the kit's materials and plan together. Because students are able to be actively involved in AMSTI lessons, educators stated that the ease of using the kits made science instruction easier to fit into teachers' daily schedule and contributed to science being taught in the classroom.

Principals' Perspectives of Teacher Dispositions

Three types of educators participated in this study: elementary science teachers, science teacher educators, and principals of elementary schools. Specifically, two principals agreed to be individually interviewed, along with teachers at their schools and two professors of elementary science methods courses at a neighboring university. Each of the participants was part of a Professional Development School- (or PDS-) type relationship. After conducting the study, the researcher noticed that the principals answered differently than the other educators that participated, even though they both taught science when they had their own classrooms. The researcher then chose to particularly look at how principals in this case study perceived effective knowledge, skills, and dispositions for elementary science teachers, and how these perceptions differed from other educators in the study. The strongest disparities were in how principals

viewed their own teaching effectiveness as science teachers, the value of teaching science, the best approach to teaching science, and science lesson planning.

When asked whether they thought that they were effective as science teachers, principals responded differently than the other educational constituents. Dr. Chappell, principal of Rosebud Elementary, stated that he thought he was effective because he enjoyed what was being taught. However, he thought that his effectiveness was hindered due to limited resources. Mr. Daniels' effectiveness (Jefferson Elementary) was tied to being able to improve on his teaching methods from year to year and students' ability to comprehend what was being taught. Teachers and science teacher educators associated their teaching effectiveness to having content knowledge. For example, Ms. Douglas (of Rosebud Elementary) expressed excitement from learning science content along with her students. Science teacher educators provided evidence of the importance of content knowledge within their elementary science methods courses. Both professors noted in their syllabi that students would learn science content that would be helpful in teaching science within their own classrooms.

Participants were also asked to share what they valued about science instruction. Principals readily exclaimed that they valued conducting experiments and involving students in hands-on science. Both principals expressed their disapproval of the science textbook being used as a primary resource. Dr. Chappell also stated that the value of science teaching was diminished because of a lack of materials. However, teachers and science teacher educators valued being able to provide students with real-life applications of science, through problem solving and preparation for future science courses. In the lesson plan that was submitted as her most effective lesson, Rosebud Elementary teacher, Ms. Dowell, stated that her lesson was beneficial because it prepared students for higher-level science courses. Also, Dr. Scott, a science teacher educator,

wanted her preservice teachers to understand that science happened every day, and all around them.

Educators often vary in their opinion of how students learn best in science. When asked for the best approach for teaching elementary science, teachers and science teacher educators shared that students should be actively involved in scientific inquiry, exploration, and discovery. At Jefferson Elementary, Ms. Elsner likes to present lessons that allows students to be involved in scientific inquiry. Her submitted lesson plan supports her claim. Science teacher educators provided class time for learning about inquiry-based teaching, science inquiry process skills, and assessment related to inquiry. Ms. Karwoski believed that her Jefferson Elementary students learned best by being able to explore before information is shared. In contrast, principals stated that teachers employ hands-on activities for effectiveness in science instruction. Both Mr. Daniels and Dr. Chappell asserted that students should be actively involved in *doing* something. The researcher noted that neither group of educators was in support of utilizing traditional techniques for instruction, such as lecture or adhering to the textbook as a main source of learning.

Finally, planning for science lessons was discussed in relation to availability of resources and having time to prepare for instruction. Administrators believed that a lack of resources would be mentioned by teachers as an obstacle to effective science teaching. Dr. Chappell specifically singled out monetary funding as being a hindrance. Teachers and science teacher educators communicated that effective elementary science teachers allow time to properly plan and prepare for science instruction. Ms. Karwoski (of Jefferson Elementary) admitted that being able to plan ahead helped her manage her time for other responsibilities. Both professors

provided time during their science methods courses to discuss how to properly plan to teach students in the area of science.

Validation and Reliability of Study

Quantitative researchers often utilize a number of techniques to determine if studies are valid and reliable. On the other hand, qualitative studies use unique criteria to validate research studies. In 1985, Lincoln and Guba provided such terms in their monumental work of *Naturalistic Inquiry*. These terms include: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). The researcher employed a number of techniques to ensure the validation of her study.

For credibility of the study, triangulation of data was utilized. Different data sources, such as interviews, lesson plans, and syllabi were recorded or gathered. For example, participants' responses were compared to the information given in lesson plans and syllabi to establish consistency. These artifacts were then analyzed by the researcher. To address transferability, thick descriptive data was provided by including participants' true responses to questions being asked in the individual and focus group interviews. This study is also transferable in that it speaks to the issue of generalization, and is designed so that the reader may be able to identify with the case study, and therefore apply it to his/her own case. Dependability refers to the researcher's process, and ensuring that the process has been recorded, is sound, and is distinguishable. Confirmability ensures that the researcher's data were not created out of his/her imagination. Both dependability and confirmability are addressed through an external audit. To handle issues of dependability and confirmability, the researcher's advisor audited the research process. Also, the researcher was reviewed by a committee of individuals within the

education profession (Lincoln & Guba, 1985; Lincoln & Guba, 1986; Creswell, 2007; Schwandt, 2007).

Future Studies

Future studies are needed to fill in remaining gaps in the study of elementary science teacher knowledge, skills, and dispositions. The researcher suggests that more studies be conducted utilizing a PDS-type model, or that tie the perspectives of elementary teachers, administrators, and science teacher educators, as well as preservice teachers, and their knowledge, skills, and dispositions of science instruction, and how they inform science education. Studies have shown that using the PDS model is effective for all those involved, including preservice teachers (Castle, Fox, & Souder, 2006; Dangel et al., 2009).

The researcher also suggests that more qualitative studies on elementary science teachers be conducted. The qualitative studies will provide rich, descriptive data that identifies details in participants' responses that may not be unearthed in certain quantitative studies. Conducting qualitative case studies such as this one, including the perspectives of principals, science teacher educators, teachers, and even preservice teachers, will help other PDS models identify and assess their own elementary science teacher dispositions, and therefore positively influence instruction. Essentially, dispositions are imperative to preparing preservice teachers and maintaining inservice teachers' effectiveness in elementary science instruction, and must be studied further.

Final Recommendations

This study provided perspectives of elementary science teachers, administrators, and science teacher educators within a PDS model. Participants shared their professional opinions on

what ideal characteristics elementary science teachers shared. These views were then compared and contrasted utilizing a case study approach. The study was beneficial in providing areas of improvement in elementary science programming for those involved in the PDS partnership.

To improve elementary science programming, teachers at Jefferson Elementary and Rosebud Elementary must be continuous learners by being involved in professional development courses and staying knowledgeable about current research related to teaching science. The principals of the study must also be involved in science professional development specific to their positions. They must constantly evaluate the science programs within their school building for effectiveness. Finally, they must show or reiterate that the teaching of science is important, and demand that it be part of the daily schedule. Science teacher educators of the study can contribute to elementary science teachers' effectiveness by providing professional development courses and training for teachers and principals. Professors can also communicate with elementary teachers to find out their concerns, and find ways to address them in their elementary science methods courses. This may alleviate preservice teachers having these concerns once they become elementary science teachers. These concerns can also be addressed in the professional development courses that were mentioned previously. All educators of this partnership must be reflective practitioners, by self-assessing the aforementioned suggestions, and by reviewing the standards that INTASC (2002) has provided for beginning science teachers, as well as NSTA's (2002) official statement regarding elementary science education.

A suggestion was made previously to share expectations in the form of standards with all those involved in the PDS relationship. The researcher also suggests that findings from these studies also be shared in the same instances and settings: during professional development,

meetings, and teacher education preparation. The sharing of these findings would help strengthen elementary science teacher programming for all involved.

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APPENDIX

Guiding Interview Questions for Elementary Science Teachers

Today we will talk about your beliefs regarding the teaching of science. As I ask each question, please state your name prior to answering.

1. How long have you been an elementary teacher of science? Briefly describe the contexts of your science teaching experience(s).
2. How often do you teach science in a week, and for how long? How often do you teach science during one semester?
3. Do you enjoy teaching science? Why or why not?
4. Do you consider yourself to be an effective science teacher? Why or why not?
5. In your opinion, what dispositions (attitudes, values, beliefs) should an elementary science teacher have in order to be effective? Why?
 - a. What are your beliefs in regards to how students learn science?
 - b. What is your approach to teaching science?
 - c. How do you assess your students in science?
 - d. How do you assess your own instruction in science?
 - e. How do you determine what will be taught within your classroom?
6. What experiences have shaped your dispositional values and beliefs about science, whether positive or negative?
7. What dispositions do you think an administrator would say are important for effective elementary science teachers?
8. What dispositions do you think an elementary science professor would say are important for effective elementary science teachers?
9. Do you think that your beliefs of teaching science have changed from when you taught science as an undergraduate student until now? How?

This concludes our focus group interview for teacher participants at your school. All of your names will be changed to protect your identity. Thank you for your participation!

Guiding Interview Questions for Elementary Administrators

Today we will talk about your beliefs regarding the teaching of science. As I ask each question, please state your name prior to answering.

1. Please indicate whether you are a principal or assistant principal, and how long you have held that position.
2. Did you teach science when you taught in the classroom? If so, for how long? Describe in what context: what/how/where did you teach science?
3. If so, did you enjoy teaching science? Why or why not?
4. Additionally, did you consider yourself to be an effective science teacher? Why or why not?
5. In your opinion, what dispositions (attitudes, values, beliefs) should an elementary science teacher have in order to be effective? Why?
 - a. What are your beliefs in regards to how students learn science?
 - b. What is the best approach to teaching science?
 - c. How should students be assessed in science?
 - d. How should teachers assess their own instruction in science?
 - e. How should teachers determine what will be taught within their classroom?
6. What experiences have shaped your dispositional values and beliefs about science, whether positive or negative?
7. What dispositions do you think an elementary science teacher would say are important for effective elementary science teachers?
8. What dispositions do you think an elementary science professor would say are important for effective elementary science teachers?
9. What do you feel should or can be done in the local schools to help teachers gain or cultivate the dispositions needed to become effective teachers of science?
10. Is there something that can be done on the university level, for those that are becoming teachers, to prepare them dispositionally to be effective science teachers? If so, what?

This concludes our focus group interview. All of your names will be changed to protect your true identity. Thank you for your participation!

Guiding Interview Questions for Elementary Science Education Professors

Today we will talk about your beliefs regarding the teaching of science. As I ask each question, please state your name prior to answering.

1. How long have you been an elementary education science professor?
2. Did you teach elementary science within a public school system prior to becoming a professor? If so, for how long? Describe in what context: what/how/where did you teach science?
3. If you taught science within a public school system, did you consider yourself to be an effective teacher at the time of leaving the classroom? Why or why not?
4. Do you consider yourself to be an effective science education teacher? Why or why not?
5. What has shaped your dispositional values and beliefs about science and science teaching, whether positive or negative?
6. In your opinion, what dispositions (attitudes, values, beliefs) should an elementary science teacher have in order to be effective? Why?
 - a. What are your beliefs in regards to how students learn science?
 - b. What is the best approach to teaching science?
 - c. How should students be assessed in science?
 - d. How should teachers assess their own instruction in science?
 - e. How should teachers determine what will be taught within the classroom?
7. What dispositions do you think an elementary science teacher would say are important for effective elementary science teachers?
8. What dispositions do you think an administrator would say are important for effective elementary science teachers?
9. What do you feel should or can be done in the local schools to help teachers gain the dispositions to become effective teachers of science?
10. Is there something that can be done on the university level, for those that are becoming teachers, to prepare them dispositionally to be effective science teachers? If so, what?

This concludes our focus group interview. Your names will be changed to protect your true identity. Thank you for your participation!