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Exploring A Five Factor Mentoring Model Within Elementary Science

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EXPLORING A FIVE FACTOR MENTORING MODEL

WITHIN ELEMENTARY SCIENCE

by

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ABSTRACT

The purpose of the study was to explore and describe the perceptions of several elementary science mentors and their mentees within one school district based on a five-factor mentoring model. Utilizing a qualitative methodology in the form of a case study, five mentors and three mentees were interviewed using a structured protocol. From verbatim interview data and field notes, three themes pertaining to the role of the mentor within elementary science emerged as emotional support, technical support, and educative support. Within the five-factor mentoring model, personal attributes suggested notions of support and expert status as critical elements for effective mentoring. The factors of system requirements, pedagogical knowledge, modeling, and feedback were found to be interrelated amongst themselves and with the factor of personal attributes. Effective mentors demonstrated a commitment to the role as well as a flexibility pertaining to role adjustment depending on the context of the mentoring relationship.

Dedicated to my family- Matthew, Todd, Jennifer, Shalom, Corbian, Saige, Madison, Hayden, Carter, and Grandma Rose. Always pursue the very best!

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CHAPTER ONE- INTRODUCTION

If teaching involves thinking on your feet and responding in appropriate ways to an ever changing situation, then one could learn to think like a teacher by working alongside an experienced practitioner who can articulate her internal dialogue with the situation (Feiman-Nemser, 1998, p. 69).

Purpose of Study

Within the educational literature, the major focus pertaining to mentorship has been on the training of pre-service teachers, the retention of new teachers, and some emphasis on new administrators (Mullen, 2005). One traditional perspective focused on encouraging new teachers to remain on the job through a form of mentorship whereby the teacher mentor provided on-site assistance to a beginning teacher (Wang & Odell, 2002). In this role, "the mentor focused on generic teaching skills or general pedagogical knowledge with little or no emphasis on subject specific skills and knowledge" (Jarvis, McKeon, Coates, & Vause, 2001, p. 6). However, in the area of elementary science, many teachers voiced concerns about a lack of pedagogical knowledge and skills needed to instruct students effectively (Duschl, Schweingruber, & Shouse, 2007; Koch & Appleton, 2007; Hudson, 2005; Rowell & Gustafson, 1993). These deficits created hesitancy and avoidance in teaching science for many new and even some veteran elementary teachers (Appleton, 2007; Hudson, Skamp, & Brooks, 2005).

Mentoring in elementary science as a form of professional development has been proposed as an effective venue for promoting the development of pedagogical content knowledge (PCK) (Koch & Appleton, 2007). Notwithstanding, effective mentorship specific to elementary science required key attributes in order to promote novice learning (Hudson, 2004; Jarvis et al., 2001). In the opening quote, Feiman-Nemser's (1998) depiction of a mentor utilizing a "think aloud" strategy to articulate knowledge and practice was a form of effective mentorship that enhanced mentee understanding of classroom contexts and demands. Personal attributes such as these assisted teachers in their roles as mentors and ultimately strengthened the professional development of their protégés (Hudson, 2004).

The purpose of this research was to explore effective mentoring strategies in order to explicate those attributes that advance positive, proactive mentorship. Through an examination of mentors and their protégés perceptions, the study sought to garner a deeper comprehension of those practices that effectively impact mentoring relationships in an effort to more completely understand the phenomenon of mentoring as it pertained to elementary science.

The Importance of Mentoring

Hargreaves and Fullan (2000) suggested mentoring was a core component of teacher leadership underscoring the transformation of the teaching profession. They contended the "social geographies of schools" were beginning to blur as the boundaries between school and community become unclear. In addition, the "social geographies of professional learning" were changing as "access to networks of professional learning" increased (p. 52). In this ever changing environment, mentoring was a significant intervention in addressing components of teacher professional development.

As teaching has grown more complex, the old model of mentoring, whereby the experienced sage relayed knowledge to an eager protégé, no longer applied (Hargreaves & Fullan, 2000). Indeed, effective mentoring needed to be guided by "an understanding of teacher learning and supported by a professional culture that favors collaboration and inquiry" (Norman & Feiman-Nemser, 2005, p. 694). Udelhofen and Larson (2003) suggested the energies and abilities of the mentor teacher and protégé, when working together, contributed toward improved learning for teachers and students. Feiman-Nemser (1998) described these energies and abilities as "the joint work of mentoring" (p. 67).

According to Hudson (2005), the joint work of mentoring elementary teachers in effective strategies for teaching and learning of science occurred more efficiently in professional settings. In a cross-case analysis of six new elementary teachers and their mentors, Roehrig, Bohn, Turner, and Pressley (2007) supported Hudson's proposition when concluding that those beginning teachers who spent more time communicating with their mentors were better able to demonstrate improved teaching practices. Within the professional setting of an elementary science classroom, the mentee could be exposed to setting up an experiment or demonstration, conducting scientific discourse, planning and assessing lessons and other effective strategies relayed through an experienced mentor (Hudson, 2007). The context of the classroom allowed for discussion and mentor modeling of “content related issues in content specific terms” (Feiman-Nemser & Parker, 1992, p.42). For the elementary teacher whose background in science may be limited due to emphasis on other foci, the mentor-mentee relationship afforded opportunities for pedagogical discourse, increased understanding of science content, and personal support (Gustafson, Guilbert, & MacDonald, 2002).

Identifying specific mentoring practices within elementary science was clearly under-represented within the literature (Appleton, 2008; Hudson, 2004, 2005, 2007; Jarvis, McKeon, Coates, & Vause, 2001; Koch & Appleton, 2007). Many studies have researched aspects of generic (non-subject specific) mentoring of pre-service and novice teachers (Feiman-Nemser, 1996; Jarvis et al., 2001). Findings from these studies have revealed attributes of effective mentors as perceived by key stakeholders. However, Jarvis et al. (2001) cited the largest proportion of mentoring involved generic content such as teaching skills or general pedagogical knowledge while subject knowledge and subject pedagogical content knowledge were neglected. This was particularly noticeable in the area of elementary science since specific mentoring processes were required for effectively instructing a protégé in those practices that best promote student understanding of concepts (Hudson, Skamp, & Brooks, 2005).

A need existed to identify current mentoring practices in view of the fact that mentoring was recognized as one key component for developing elementary science teachers’ practices (Gustafson et al., 2002, Hudson, 2004; Hudson et al., 2005; Jarvis et al., 2001). It was important to explore and describe the factors contributing to effective mentoring in elementary science in order to more completely understand the phenomena, and from this understanding, contribute to a limited knowledge base thereby strengthening the profession.

Conceptual Framework

The conceptual framework for the study was based on the five-factor mentoring model proposed by Hudson (2004) in the *European Journal of Teacher Education.* It illustrated explicit effectual practices within elementary science mentoring that promoted valuable teaching skills and dispositions within novice teachers. This form of mentoring enabled mentors to "become agents of systemic change" (p. 142). The five key factors when considering effective mentorship were personal attributes, system requirements, pedagogical knowledge, modeling and feedback.

Personal attributes underscored all subsequent factors because it required the mentor to develop a relationship with a mentee that was positive and supportive (Hudson, 2005). Mentors needed to demonstrate good listening skills, reflective discourse, and a willingness to pursue a mentee's educational interests within the context of the classroom. Nested within personal attributes, the concept of educative mentoring illuminated mentors who assisted mentees "to interpret what their students said and did, and then to figure out how to move their students' learning forward" (Norman & Feiman-Nemser, 2005, p. 680). Educative mentoring was first described by Feiman-Nemser (1998) as "mentoring that helped novices learn to teach and develop skills and dispositions which encouraged continued learning in and from their practice" (p. 66).

According to the five-factor model, system requirements pertained to obtainable goals for teaching elementary science, relevant school policies, and science content curriculum (Hudson, 2007; Shea & Greenwood, 2007). This involved the mentor relaying technical advice supporting elementary science instruction. The mentee was made aware of policies and practices for implementing curriculum documents including local safety concerns and issues. The next factor, pedagogical knowledge, involved content knowledge as well as planning, timetabling lessons, teaching strategies, problem solving, classroom management, questioning skills, implementing effective practices and assessment (Hudson, Skamp & Brooks, 2005; Schavarien & Cosgrove, 1997). Mentoring was a "think aloud intellectual activity" that assisted the mentee in "fostering an inquiry stance" toward developing "pedagogical thinking" about elementary science (Feiman-Nemser, 1998, p. 69).

Modeling, as the fourth factor, implied willingness by the mentor to model effective science instruction through enthusiasm, a rapport with students, lesson planning, syllabus language, hands-on lessons and classroom management (Appleton, 2008; Jarvis et al., 2001; Schavarien & Cosgrove, 1997). However, the modeling was a mutual activity in which the mentor and mentee each showcased individual instructional styles. The mentee engaged in the authentic task of teaching while the mentor took the lead when appropriate (Norman & Feiman-Nemser, 2005). Feedback, as the fifth factor, described a type of communication between mentor and mentee when evaluating the outcome of student learning and setting clear expectations for the mentee (Hudson, 2005). When practicing feedback in the form of educative mentoring, articulation was not a one-way street, but resulted from the mentor and mentee doing and talking about the work together (Feiman-Nemser, 1998).

This conceptual framework for mentoring within elementary science guided the study because it provided a means for the researcher to explicate effective mentoring strategies. Mentors had definite notions of the types of instruction they wanted to foster (Feiman-Nemser, 1998). They considered the mentee as a learner and exhibited attributes of the five-factor model as a means towards promoting effective science teaching and learning (Hudson, 2004). Given the under-representation of effective mentoring practices within the literature (Appleton, 2008; Hudson, 2004,2005, 2007; Hudson, Skamp & Brooks, 2005; Jarvis, McKeon, Coates, & Vause, 2001; Koch & Appleton, 2007), this framework provided a venue for thinking and examining what effective mentoring could look like in the elementary science classroom. In addition, it helped to direct the design of the study through the framing of interview questions and analysis of participant responses when considering the five factors for effective mentorship.

Guiding Questions

(1) What was the role of an elementary science mentor?

(2)What were elementary science mentors' perceptions of their practices in relation to the five-factor mentoring model?

(3) How did the mentees perceive the practices of their mentor in relation to the mentoring model?

The study was guided by the above stated questions. The first question examined the types of roles elementary science mentors played within their school, their interactions with the mentee, and their professional lives. Typically within public education, two types of mentorship were fostered (Mullen, 2005). The most traditional was formal mentorship involving a one-on-one arrangement designated within the institution. Informal or alternative mentoring constituted the other example. This type was usually not structured nor officially recognized. In looking at the roles mentors played within the study, the forms of mentoring were noted as well as the peculiar dynamics of each mentoring dyad relationship.

The second and third guiding questions were predicated upon the conceptual framework of the study. Effective mentoring practices in elementary science were identified within the literature to consist of five factors that contributed toward the professional development of a mentee (Hudson, 2004, 2005, 2007; Hudson, Skamp & Brooks, 2005; Jarvis et al., 2001). These five factors combined with the embedded paradigm of educative mentoring guided the collection of data and were foundational to the development of interview questions for mentors and mentees.

<u>Design of the Study</u>

This qualitative study employed the methodology of a case study to examine the perceptions of mentors and mentees within a five-factor mentoring model based on the research of Hudson (2004, 2005, & 2007) and Hudson, Skamp and Brooks (2005). The researcher initiated a modified snowball sampling technique in order to enlist participants for the study.

From this sampling, five mentors and three mentees were purposively chosen because of their participation in elementary science mentoring experiences within the past three years. Through structured and semi-structured interviews as well as field notes, the researcher collected data of the individual's perceptions of the mentoring experience. The conceptual framework, related to five factors established within the literature as effective in demonstrating a proactive, positive mentoring relationship (Hudson et al., 2005), guided the formulation of the interview questions.

The interviews were transcribed and analyzed based on Miles and Huberman's (1994) techniques for qualitative designs. To facilitate this process, verbatim data were recorded using a two column matrix which allowed for initial sorting relating to the five factors for effective mentoring. These five factors were personal attributes demonstrated by the mentors, system requirements, pedagogical knowledge, modeling and feedback as well as forms of mentoring identified by each mentor/mentee relationship. Once sorted, data were examined through a comparison of responses between and amongst the dyad mentoring relationships. This occurred as a result of multiple readings and re-readings which helped to identify recurring themes. Patterns and exceptions to patterns were noted helping to provide a thick, rich description of elementary science mentoring experiences.

Delimitations, Limitations and Assumptions

The purpose of the study was to explore and describe within a five-factor mentoring model (i.e., personal attributes, systems requirements, pedagogical knowledge, modeling, and feedback) the perceptions of several elementary science mentors and their mentees within one school district. The researcher sought to capture the quality and degree to which mentors implemented knowledge and skills for effective mentoring. In essence, would the perceptions of mentors and the mentees reveal effective practices involving attributes consistent with the literature for quality mentoring? Through collection, analysis, and reporting of the findings, illumination of the role mentors played in the lives of the mentee could contribute to existing literature within the field as well as illustrate effectual practices needed for the development of positive, proactive elementary science mentoring.

One delimiting factor for the study was the population to which generalizations could be made. Initial identification of elementary science mentors began with district personnel; these individuals were considered gatekeepers and received a list of identified characteristics and criteria for mentor selection and recommendation. Certain characteristics were chosen because they allowed for an effective representative sample population. Given the small number of teachers who actually mentor elementary teachers in science, the researcher acknowledged the possibility of a small sample size of possibly two to three mentoring dyads. Since the study was qualitative in nature as well as utilizing a small purposive sample, the potential to be generalized to a larger population was negated.

Limitations for the study were bound by time and space. Accessing the potential population and collecting data occurred during the fall of the 2009 school year within Brevard County school district. In addition, personal biases may have been brought to the situation that could affect the quality of analysis and synthesis. In an attempt to mitigate the potential effects of these biases, a bracketed interview was employed. The interview was conducted with another graduate student and data were discussed pertaining to assumptions about what effective mentoring looks like and how it will present itself within conversations with participants.

Assumptions for this case study included reliance on gatekeepers for accuracy and fairness in selecting mentors for possible participation. These gatekeepers were the elementary school principals within Brevard County and the district's elementary science coordinator. As administrators, their positions allowed them to supervise and evaluate teachers plus compare and rank teacher effectiveness in the classroom and in a mentoring relationship. Their choice of teachers hopefully reflected the criteria delineated within the letter to the gatekeepers (see Appendix A-1). In addition, another assumption included honest and self-reflective reporting from the elementary science mentors and their mentees. Since all data were based on the reports of each participant, it was presumed these reports accurately reflected perceptions of mentoring practice.

Organization of Dissertation

In Chapter one, the researcher introduced the idea of elementary science as a subject in which some teachers were hesitant to teach and may have practiced "subject avoidance" behaviors (Appleton, 2008; Koch & Appleton, 2007). However, mentoring within elementary science was considered a means toward addressing some of these professional deficits (Hudson, 2004, 2005; Hudson, Skamp, & Brooks, 2005). This area was not well represented within the literature, (Appleton, 2008; Hudson, 2004, 2005, 2007; Jarvis, McKeon, Coates, & Vause, 2001; Koch & Appleton, 2007; Schavarien & Cosgrove, 1997). There was a need to ascertain effectual elementary science mentoring practices in an effort to positively impact future mentoring processes as well as contribute to a very limited knowledge base.

Utilizing a conceptual framework based on a five-factor mentoring model (Hudson, 2004; Hudson et al., 2005) with the embedded notion of educative mentoring (Feiman-Nemser, 1998), the current study sought to explore and describe the perceptions of five elementary science mentors and three mentees. The five factors within the model were personal attributes, system requirements, pedagogical knowledge, modeling, and feedback. The conceptual framework guided the design of this qualitative case study since it served as a lens through which interview questions were formulated and analyzed.

Within the next chapter, a relevant review of the literature on mentoring in elementary science will be presented. The review includes examples of reform movements affecting elementary science classroom practice, mentoring as a form of professional development, mentoring within elementary science, and a close examination of the five factors for effective mentoring. In chapter three, a rationale for the study's methodology was discussed as well as sampling techniques, data collection, and data analysis. Chapter four presented the findings within two sections that described the role of the mentors, and the five-factor mentoring model. Concluding the study in chapter five, the researcher chose to use the guiding questions in which to frame the conclusions and also included implications for future research.

Definition of Terms

1. Gatekeeper- someone who controls access to something (American Heritage Dictionary, 2000)
2. Mentee- an individual willing to participate within a mentoring relationship (Mullins, 2005)
3. Mentor- an experienced, veteran teacher skilled at providing instructional support and committed to the role of coaching a new teacher (Ingersoll & Smith, 2004)
4. Mentoring- "a personal or professional relationship between two people, that being a knowledgeable, experienced professional and a novice or mentee, who commit to an advisory and non-evaluative relationship that often involves long term goals" (Mullins, 2005, p. 1)
5. Mentorship- "an educational process focused on teaching and learning within dyads, groups and cultures" (Mullins, 2005, p. 1)

CHAPTER TWO- LITERATURE REVIEW

Elementary science instruction can be an area of insecurity for many teachers, both novice and veteran (Appleton, 2008; Duschl, Schweingruber & Shouse, 2007; Koch & Appleton, 2007; Hudson, 2005; Rowell & Gustafson, 1993). Professional development opportunities in the form of mentoring are one means to address some of the needs and concerns of elementary teachers (Appleton, 2008; Schavarien & Cosgrove, 1997). However, most mentoring tends to be generic in nature and not subject specific, thus limiting the development of a protégé's pedagogical content knowledge (Jarvis et al., 2001). Identification of effectual practices that promote positive, proactive mentoring within elementary science are needed when impacting a mentee's knowledge base and effecting change in classroom practices (Hudson, 2004, 2005, & 2007).

Given this line of reasoning, a search within the literature for effective mentoring practices led to an examination of research pertaining to mentoring within the field of elementary science. Since the research offers few examples of effective mentorship (Appleton, 2008; Koch & Appleton, 2007), generic mentoring was investigated for possible insights into strategies that could be applied to elementary science mentoring. Throughout the literature, mentoring is referred to as a form of professional development (Hargreaves & Fullan, 2000); however, cultural influences stemming from reform movements impact professional development opportunities which in turn affect notions of mentoring (Wang & Odell, 2002; 2007). An exploration of several cultural perspectives pertaining to mentoring led the researcher to ponder what types of reform influence professional development opportunities and what did these reform movements look like. In examining subject specific mentoring, elementary science reforms suggest significant changes to classroom practice which may be extrapolated in a teacher's professional development (Smith & Southerland, 2007). If this professional development is in the form of mentoring, effective strategies and practices that relate to science pedagogical content knowledge could be relayed and modeled for the protégé. This rationale frames the organization of the literature review.

The main goal of this literature review is to integrate and generalize findings pertaining to the importance of mentoring that is subject specific to elementary science as well as explicit practices for effective mentorship. While the focus is aimed at searching for practical applications of mentoring knowledge, the explanation of certain propositions supporting the research rationale underscore the importance of mentoring within elementary science and the need to identify useful practices that could positively impact novice development. These propositions result from an analysis of the literature related to elementary science mentorship and consist of the following: (1) Elementary science has been impacted by reform movements which affect classroom practice (2) Professional development opportunities are one means of addressing change in education, in particular is an individualized form of professional development known as mentoring. (3) Cultural perspectives surrounding mentoring influence its practice especially in light of the notion of educative mentoring. (4) In elementary science, certain mentoring practices are cited as effective in underscoring professional development. (5)

The qualities of mentorship noted within the five-factor model ascribed by Hudson (2004) provide a venue for effectual mentoring practices.

Reform in Elementary Science Education

Within the past fifty years, two major reform efforts in K-12 science education have occurred. These reform efforts are noteworthy because they affect the educational landscape of the elementary science classroom (Smith & Southerland, 2007). The way in which science is taught was modified based on changing ideas of how students learn. In examining these notions of science learning and teaching, they represent movement away from the dominant focus on conceptual learning to a more balanced focus on integrating conceptual, epistemic, and social elements within the classroom (Duschl, 2008). More importantly, they impact classroom practice for the elementary teacher.

The first curriculum reform efforts were motivated by the launch of Sputnik and the creation of the National Science Foundation (NSF) during the 1950 to 1970's. The underlying objective for this reform is to develop students' scientific thinking (Duschl, 2008). The focus is on what students need "to do" with emphasis on hands-on manipulation. This is usually accomplished in discrete, short lesson sets illustrating a scientific concept. However, Duschl purports these efforts lack the "dialogic knowledge-building processes" needed to enhance conceptual understanding (p. 270). Student hands-on science lessons does not necessarily equate to student understanding of the concepts underscoring that manipulation.

The second reform effort began in the 1980’s and has continued as a part of the national standards movement; its primary goal is to develop a scientifically literate population. Duschl, Schweingruber & Shouse (2007) describe a scientifically literate population consisting of individuals who are not only capable of understanding but evaluating information that is scientific in nature. These individuals not only utilize this understanding to make appropriate decisions in everyday life but could possibly cultivate careers as skilled scientists, engineers, and other science based professions.

This paradigm shift occurred as a result of focusing on two scholarly domains: learning sciences and science studies (Duschl, 2008). Within the learning sciences, previously held notions about how children learn have been replaced with a deeper understanding of student thinking and reasoning. These notions differ radically from adult learning. Sawyer (2006) suggests, students who are “engaged in activities that are similar to the everyday activities of professionals who work in a discipline” (p. 4) tend to develop a deeper and more comprehensive understanding of the subject. In combination with this perspective are findings within the science studies literature that recognize scientific knowledge changing over time as well as the methods of inquiry and criteria for evaluating the way knowledge changes (Duschl, 2008). In applying this to the science classroom, students are expected to “build theories and models, construct arguments, and use specialized ways of talking, writing, and representing science phenomena” (Duschl, 2008, p. 276). Through these actions, students can demonstrate certain mannerisms that eventually build scientific literacy.

Teaching and learning science has become more complex. Duschl et al., (2007) stipulates expectations for student behaviors within the science classroom to include "explanations of the natural world" based on individual knowledge and interpretation. With these explanations, students "generate and evaluate scientific evidence" as well as "develop scientific knowledge" (p. 42). The purpose of curriculum is to assist the elementary science teacher in building factual knowledge and concept development within the child in order to promote scientific practices (Duschl, 2008). Prototypical science teaching which includes reading from a textbook and completing a worksheet is insufficient to build student understanding (Carlone, 2003). Although, experimentation and hands-on manipulation are still relevant and important, scientific discourse is the premium commodity (Duschl, 2008).

This paradigm for teaching and learning science illustrates a multifaceted reform encompassing conceptual, epistemic and social processes. Indeed, much thought and effort needs to be given towards science instruction, if the individual classroom teacher is to develop a practice consistent with current research (Duschl, 2008). Elementary science teachers need to reconsider their approaches to the curriculum, instruction and assessment and ultimately re-evaluate their practice.

Although the literature indicates some teachers openly embracing change (Crawford, 2000), other teachers are either unwilling or lack the skills and knowledge to incorporate reform-minded practices (Davis, 2003; Tilgner, 1990; Vesilind & Jones, 1998). Representative of some of the literature referencing teacher reaction to reform is a comparative, multi-case study of two elementary science teachers in two different settings (Smith & Southerland, 2007). The researchers utilize a qualitative methodology to describe and interpret individual teachers' beliefs about specific reform tools and how it impacts practice. These reform tools include the National Science Standards (1996), science curricula mandated by the state, and science criterion-referenced testing.

Smith and Southerland (2007) purposively select two teachers from a group of 1200 based on the results of the Participant Selection Survey, similarity in personal characteristics, individual school setting demographics as well as personal knowledge of current science reform. One teacher was responsible for teaching all subjects to a group of 30 sixth graders while the second teacher taught fifth grade in a modified departmentalized setting. Although this fifth grade teacher was responsible for the brunt of curriculum instruction to her class, she did teach science to all four fifth grade classes four times a week. The authors concede that these two individuals were chosen, in part, because of their professed knowledge of certain science reform documents, and they did not appear to represent the typical elementary teacher in the area of science education.

Despite a focused selection based on similar characteristics, Smith and Southerland (2007) indicate incongruent results due to each teacher's personal teaching philosophy. For both teachers, the standards documents had been "browsed through briefly" but "contributed little to each teacher's day to day thinking about science instruction" (p. 406). Indeed, one teacher suggested that, "teachers are too busy and don't have time to read such things" (p. 406). Although, the teachers did not appear to be strongly influenced by the standards documents, the authors posit the greatest disparity within each teacher's approach to inquiry. The sixth grade teacher had participated in several professional development opportunities emphasizing an inquiry-based approach to teaching science. Even though she acknowledged its benefits, she doubted that "inquiry led to real learning of science content" (p. 408).

The fifth grade teacher, while not having the opportunities to deeply investigate inquiry-based instruction, held "basic beliefs about science and science teaching and learning that closely aligned with reform documents" (p. 410). Within her daily practice, she encouraged students to take "an active role in constructing an understanding of science concepts using science processes" (p. 410). However, this teacher struggled with the connection between her daily science lessons and state assessments arguing that there was little match between standards and the test. She felt the messages she received from reform tools were confusing since teaching students to be critical thinkers in science and then giving them a multiple choice test for assessment was conflicting.

Smith and Southerland (2007) conclude the differences between these teacher's personal theories about teaching science and their actual practice can be attributed to ambiguous understandings of what was expected of them. The tools of reform, instead of providing clear guidelines for instruction, provide images that are often confusing and contradictory. This, in turn, added to frustration and insecurity within the teacher's daily practice. If these frustrations were noted by two experienced elementary science teachers, how much more would novices struggle with implementing effective science instruction based on reform-minded philosophies? Given the demands of school culture and classroom practices, instructing with a reform-minded perspective is a highly difficult venture that few novices are able to conduct (Wang & Odell,

2002) Other literature articles have also noted similar findings. Vesilind and Jones (1998) indicate the goals of a highly visible hands-on science curriculum conflict with teachers' goals to cover curriculum and the public's goals for reading and math achievement via high stakes testing. Davis (2003) suggests teacher resistance to science initiatives is based on limited understanding of what is needed for effective instruction.

The literature on elementary science reform encourages an expanded role for educators including concept development within students plus development of scientific literacy (American Association for the Advancement of Science, 1989, 1993a, 1993b). The reform documents suggest changes to methods of teacher preparation and strategies for professional development (Eady, 2008). This affects what is important for teachers to learn and how they will learn it. In the case of elementary science mentoring as a form of professional development, it impacts the substance of teacher knowledge and the process of learning to teach science to young children.

Learning to teach is a complex process requiring time and effort. It is a process that can "take place across a variety of contexts" (Davis, 2003, p. 6). For many teachers in elementary science, this context has been affected by some form of professional development. Within the next section, the proposition of mentoring as a form of professional development in order to address the reform movement and strengthen elementary science is examined.

Mentoring as a form of Professional Development

Teacher insecurities when teaching science especially in the face of reform is a widespread theme within the literature (Appleton, 2008; Duschl, Schweingruber & Shouse, 2007; Koch & Appleton, 2007; Hudson, 2005; Rowell & Gustafson, 1993). Available data suggests 71% of elementary school teachers reporting a need to deepen their level of science content knowledge as well as increase understanding of student thinking in science and how to assess science learning (Weiss, Banilower, McMahon, & Smith, 2001). One common strategy for addressing these issues is professional development. Appleton (2008) posits the need for sustained professional development opportunities within elementary science is great since elementary teachers "need considerable support in developing their knowledge base" (p. 527). Mentoring as a form of individualized, situated professional development is one possible venue for promoting growth since mentoring is cited as a means of strengthening and improving the profession (Hargreaves & Fullan, 2000) Within elementary science, subject specific mentoring is noted to underscore protégé pedagogical content knowledge (Appleton, 2008) thereby impacting classroom practice.

Students majoring in elementary education are often viewed as generalists due to limited course work in a discipline versus the extensive coursework of secondary education students. Secondary coursework focuses on understanding "the methods, products, and relationship to society within a single discipline" (Loucks-Horsley, Carlson, Brink, Horwitz, Marsh, Pratt, Roy, & Worth, 1989, p. 19). Elementary education majors are required to develop an understanding of language arts, math, science and social studies with the main focus on methods for teaching each subject. According to the authors, professional development for teachers of elementary science is compartmentalized into distinct stages. These stages typically include science coursework, professional education coursework, clinical experiences and in-service education.

However, what is taught at each stage is the responsibility of different people and institutions; there is "rarely coherence or continuity across stages and responsible parties" (p. 19). As a result, there is no one institution or "formal collection of institutions" responsible for ensuring that teachers have the science and science teaching knowledge they need. This is left to the individual elementary school teacher. For the newly hired or veteran elementary science teacher who desires to deepen her pedagogical content knowledge, "professional development is largely learning by doing" (p.19).

As reform movements impact science curriculum and instruction, paradigm shifts for teacher learning modify the arena of professional development (Duschl, 2008). Previously held notions contend teacher knowledge is produced by others, whereas, more current understandings describe teacher knowledge residing within teachers (Abell, 2007). This idea is based on a constructivist perspective in which knowledge is conceptualized into "clusters of similar experiences, often called schemata" (Appleton, 2007, p. 33). In particular, science pedagogical content knowledge is the knowledge a teacher uses to "construct and implement a science learning experience or series of science learning experiences" (p. 35).

Concurrently with this point of view is the development of new theories of teacher learning situating the individual within an authentic context (Abell, 2007). Putnam and Borko (2000) propose "authentic context" to include practicing teachers conducting activities at their school sites or elementary education majors taking part in apprenticeships in which the individual gradually gains more responsibility. This approach draws on an assumption of apprenticeship in an existing environment, in which "important learning to teach takes place as novices experience actual classrooms alongside experienced teachers" (p.7). Models of teacher apprenticeship usually include field experiences. These experiences come in many shapes and sizes. Typically, field experiences begin at the start of teacher preparation programs for the purpose of initiating students into the field. Depending on the program, they possibly continue in conjunction with methods courses. However, for most students, field experiences are a culmination of teacher education coursework (Abell, 2007).

There is another form of professional development which situates the novice in an authentic context. This form is mentoring. Mentoring allows teachers to construct meaning from instructional experiences while participating within the context of the classroom. Lave and Wegner (1991) suggests this kind of participation involves "talking about and talking within practice" (p. 109). For the protégé, learning "to talk" about teaching and learning is as important as listening "from talk" about the nature of teaching. This notion is supported by other individuals in the field, since mentoring is considered a collaborative effort between mentor and mentee that endorses professional growth (Feiman-Nemser, 1996 & 1998). Mentoring, according to Feiman-Nemser (1998), is "a blend of showing and telling, asking and listening in ways that promote new teacher learning" (p. 680).

Parker-Katz and Bay (2008) explore the notion of mentor constructed knowledge and its impact upon teacher education programs as a possible professional growth opportunity. In their study, seventeen mentors were selected from a large school district which was predominately urban. All mentors had participated within university teacher preparation programs and reflected diverse teacher backgrounds. These elementary teachers as mentors were selected based on a set of criteria designed by the researchers. The seventeen participants were divided into two focus groups that met monthly for six months in order to discuss a set of topics selected by the university personnel.

From transcripts and field notes, Parker-Katz and Bay (2008) indicate the emergence of three themes that align with the situated-learning perspective. The mentors were concerned with "who they wanted the novice to become as a teacher of students and as a learner of teaching" (p. 1265). The mentors ascribed to holistic perceptions of their pupils as well as their student teachers. The mentors viewed "their students' learning through multiple lenses" and believed this was an important perspective that needed to be developed within novice teachers. Finally, the mentors saw "collaborative teaching between mentor and student teacher" (p. 1266) as a means towards integrating the focus on student learning with other aspects of teaching. Parker-Katz and Bay label this "collective responsibility" and address the notion of the novice as an integral part of the faculty who is interwoven within daily school life.

In examining mentor constructed knowledge, the belief that new teachers need only "absorb a static body of knowledge and set of skills" in order to effectively teach is challenged (Parker-Katz & Bay, 2008, p. 1268). Mentors brought to the surface the need for novices "to develop kernels of teaching beliefs and knowledge" when developing teacher identity, collective responsibility, and focusing on student learning. Through the participant mentors, assumptions about each teacher's role in actively constructing knowledge about teaching and learning were made explicit. These discussions made clear the importance of authentic context in promoting the development of the novice. For the researchers, Parker-Katz and Bay, mentoring is a form of individualized professional development that would aid student teachers in ways that the university's teacher preparation program could not.

This notion of mentoring as individualized professional development was first discussed by Feiman-Nemser (1998) when coining the phrase "educative mentoring". It became a core idea when constructing the conceptual framework for the present study because notions for effective mentorship were made explicit. Within the next section of this literature review, the concept is examined within the context of cultural perspectives related to mentorship.

Mentorship

Mentorship is sanctioned as a viable means toward strengthening the teaching profession (Feiman- Nemser, 1996, 1998, 2001; Fullan, 1993; Hargreaves & Fullan, 2000; Mullins, 2005; Schwille, 2008) because it offers the possibility of contributing towards professional growth, impacting classroom practices, and serving as a catalyst for reform. The literature base for mentorship is quite extensive examining general strategies for mentoring, mentoring perspectives, mentoring programs and some subject-specific mentoring practices (Feiman-Nemser, 1996, 1998, 2001; Huling, 2001; Odell & Huling, 2000; Wang & Odell, 2002, 2007). It is subject-specific mentoring practices related to elementary science that composes the central topic of this research study. Embedded within the framework for subject-specific mentoring practices is the notion of educative mentoring. Educative mentoring is a form of mentoring whereby the mentor makes thinking visible and explains the principles behind the practice. Indeed, the mentor helps to create "an individualized curriculum for learning to teach tailored to the specific strengths and vulnerabilities of a particular novice within a specific context"

(Feiman-Nemser, 2003, p. 29). Concepts of educative mentoring are illustrative of cultural perspectives since they describe particular beliefs about social institutions.

Mullen (2005) divides mentorship into two broad categories encompassing cultural perspectives: technical mentors and alternative mentors. The first set of beliefs about mentors designates them as "top down guides in the role as expert and teacher. This role is transmissive in nature rather than collegial." (p. 35) and is titled "technical mentors". There is great emphasis within the perspective on reinforcing the status quo especially when managing formal organizational roles. This type of mentoring is helpful and necessary within a variety of settings when lending support to new teachers. Mentors are assigned as guides or act as peer coaches. Depending on the relationship, technical mentorship could promote professional inquiry. Observation and feedback can possibly be used by the mentor to assist new as well as experienced teachers in a variety of situations. Although they are not supervisors or formal evaluators, their feedback could have an "evaluative dimension" in preparing teachers for types of formative assessment (Danielson & McGreal, 2000).

A second perspective about mentoring suggests a greater desire to "enhance the development and education of protégés outside the traditional supervisory or advisory context" (Mullen, 2005, p. 38). This form of mentoring, known as alternative mentoring, attempts to remedy some of the perceived drawbacks of the more traditional view as well as promote equity for all educators. However, there is no set framework for this type of mentoring. Mullen notes six major concepts within the paradigm of alternative mentorship: collaborative mentoring, lifelong mentoring, sociocultural learning activity, mentoring mosaic, mentoring communities, and mentoring leadership. The greatest commonality within the concepts is the challenge to assumptions about hierarchy, rank, and status. In addition, these types of mentoring relationships are mutual and non-evaluative in nature.

In Mullin's (2005) presentation of mentorship, there are hints of problems related to power differentials within a mentor-mentee relationship. An attitude pervades the mentoring literature in which the positive effects are "taken for granted" (p. 38). Feiman-Nemser (1996), in a critical review of teacher mentoring, cautions educators to examine the claims of mentoring with more rigorous scrutiny since some studies indicate mentors promoting "conventional norms and practices thus limiting reform" (p. 2). Other researchers discuss these conventional norms in terms of "mentor reproduction" combined with elements of power and control (Colley, 2002; Sundli, 2006).

In a study of Norwegian pre-service teachers engaged in their final segment of internship, Sundli (2006) suggests teachers not only copying mentors' work patterns, but mimicking body language, vocabulary and even ways of expressing theories. In addition, the process for validating the student's teaching performance mainly consisted of worrying about how the intern followed the teaching program and how they managed to get through the planned work. The author posits that in the absence of explicit assessment criteria, the intern's desire "to master the situation and secure it by 'cloning' the mentor in her way of behaving" (p. 47) may have contributed to the situation. Despite adverse indications from the data, Sundli did not advise "throwing the baby out with the bathwater" but argues for enhanced mentor training within teacher education programs so that it is not an “obstacle to professional reflective teaching” (p. 214).

Colley (2002) underscores the notion of “mentor reproduction” in her unique analysis of mentorship entitled, *A ‘Rough Guide’ to the History of Mentoring from a Marxist Feminist Perspective.* She identifies four historical stages related to mentorship beginning with mentor roles defined by myths and moving through a modern view of mentoring. Colley criticizes the literature as biased in favor of mentoring and suggests this bias is due to the way “in which mentoring is routinely disembedded from its social, economic, and political contexts” (p. 259). She suggests an examination of the specific contexts of mentor relationships and the ways in which mentors and mentees construct their roles. Although, Colley’s paper drew from a project involving mentoring relationships with “disaffected youths”, she relates her experience of conducting in-service training for mentoring to her overall appraisal of mentorship. Similar to others within the literature (Feiman-Nemser, 1996, 1998), she, too, advocates for more detailed empirical investigations about mentoring citing its importance as a possible “change agent” within education.

The notion of teacher mentors as “change agents” was first introduced by Fullan (1993) and later explicated in an article entitled, *Mentoring in the New Millennium* (Hargreaves and Fullan, 2000) The authors propose mentoring as a means towards “transforming teaching into a true learning profession” (p. 55). In order for this to occur, old conceptions of mentoring as a one-on-one venture are replaced with mentoring as an integral component of school culture. Singular focus on student learning outcomes is modified to include building and strengthening relationships with colleagues and parents. Mentoring as a “hierarchal dispensation of knowledge” amends to a view incorporating “shared inquiries into practice” (p. 55). Finally, mentoring as an isolated innovation moves toward mentoring as a broad improvement effort in reculturing schools and school systems. The role of the mentor is to guide novices through learning standards and skill sets and to also provide strong emotional support. This cultural perception of mentoring is similar to Mullins’s (2005) category of alternative mentorship in which traditional supervisory roles of the mentor are expanded into more contemporary relationships and structures.

In describing cultural perceptions about mentoring, Wang and Odell (2007) also challenge assumptions about mentorship, claiming them to be problematic when socializing new teachers into existing school cultures. Traditionally, the mentee’s mastery of isolated concepts in a prescribed sequence is an assumption of learning that needs to be replaced because it did not include “the context of teaching or the complexity of mentoring relationships” (p. 473). A broader, reform-minded perspective that is consistent with the social, economic, and political needs of society more appropriately addresses the needs of novices. Wang and Odell describe three existing conceptions of mentor-novice relationships as humanistic perspective, situated-apprentice perspective, or critical constructivist perspective. Each perception ascribes a view of learning within its fundamental premise.

The main goal of the humanistic perspective mentor-novice relationship is to provide a smooth transition into teaching by dealing with the psychological demands associated with induction into the profession (Wang & Odell, 2007). The role of the mentor is that of a counselor assisting the mentee with identifying issues and creating solutions in order to promote self-efficacy. The second perspective concerns situated-learning and assumes all knowledge is contextualized; its main goal is to assist the novice in the transition from theory learned in college to application and practice. The role of the mentor within this framework is that of an expert "articulating practical knowledge through coaching and demonstration, identifying resources, and providing contexts where novices learn to teach as needed in the existing culture" (p. 476). The third perspective negotiates critical theory with constructivist assumptions. The goal of critical constructivist perception is to critique existing knowledge structures and cultures of teaching while committing to reform-minded teaching. The role of the mentor is viewed as an "agent of change". Mentors know how to work with new teachers in promoting articulation about existing knowledge and teaching as well as evaluating new ideas about teaching.

Schwille (2008) reconstructs mentor roles described by Wang and Odell (2007) into a more fluid description. She stipulates, "Mentoring is differentiated work in that mentors determine and adjust what they know about their learners and what needs to be learned…. Learning to mentor is a process of developing a practice based on a conceptual stance toward mentoring" (p. 143). Utilizing a cross national study of mentoring preservice and beginning teachers entitled, "Learning from Mentoring", Schwille observed and interviewed 26 pairs of mentors from China, England and the United States. Of the 26 pairs, 16 were either middle or high school level and 10 were in elementary schools. In some instances, the mentee was videotaped while teaching when the mentor was present, and then the mentor and novice were videotaped during a post-teaching conference.

Schwille (2008) notes patterns of effective mentoring behaviors can be loosely grouped into two categories. "Inside the action" mentoring includes coaching and stepping in while the novice was teaching, or co-teaching, and demonstration teaching. "Outside the action" mentoring also includes demonstration teaching as well as brief interactions, mentoring sessions, debriefing sessions, co-planning, videotaped analysis and journal writing. In all cases, mentors participated in more than one form of mentoring dependent on the needs of the novice. In fact, quite frequently mentoring behaviors were improvised and adapted to suit the situation and the novice's learning while relying on the individual mentor's strategic knowledge and judgments. She states, "Mentoring as a professional practice means that mentoring is an educational intervention…Forms of mentoring are used to support the purpose of mentoring which is to promote novices' learning" (p. 160). Consistent with the notion of alternative mentorship as a sociocultural learning activity, Schwille focuses her descriptions of mentorship as a professional practice in which "both mentors and novices work together to learn teaching" (p. 164).

Resonant within much of the mentoring literature describing alternative forms of mentorship is the seminal work of Sharon Feiman-Nemser. She has authored or co-authored more than sixteen articles pertaining to mentoring within education. It was Feiman-Nemser (1998) who first coined the phrase "educative mentoring" when describing mentoring practice as an individualized form of professional development. This is not the typical top-down model whereby knowledge is relayed from sage to novice, but involves collaborative efforts between mentors and mentees when thinking, planning, and implementing instruction. It encourages communicating knowledge, "ways of thinking", and "processes of inquiry" (p. 69). In a later article, co-authored with Patricia Norman, Feiman-Nemser further clarifies the role of an educative mentor to include a blend of "showing and telling, asking and listening in ways that promote new teacher learning" (2005, p. 680).

To illustrate an example of an effective educative mentor, Feiman-Nemser (2001) utilized a qualitative case study design focusing on one mentor's practices. The mentor, Pete Frazer, was a 30 year veteran teacher who worked full time as a support teacher in an induction/internship program jointly sponsored by a local university and school district. Like the other mentors within the program, Pete worked with several beginning teachers in a role that encouraged supporting an intern's unique teaching style with promoting a shared understanding of good practice. However, he was unique amongst other mentors because of his educational background which included earning a doctorate, teaching at the university, and instructing numerous teacher in-service workshops.

Through an analysis of 10 hours of interview data plus an equal amount of observational data spread over two years, Feiman-Nemser (2001) describes multiple patterns of effective mentoring. These patterns include the mentor "finding openings" that lead toward fruitful discussions on topics relevant to the novice as well as issues necessary for daily teaching activities. "Pinpointing problems" and "probing novice's thinking" are dialogic techniques employed by the mentor in order to assist the novice with articulating practice, problem solving, and fostering an analytic stance. As a form of encouragement, the mentor notices and comments specifically on "signs of growth" when the novice is concerned about his/her own performance in addition to attending to the classroom students' thinking and sense making. When attempting to bridge theory with practice, the mentor reinforces an understanding of theory in context and provides "living examples" through demonstrations and ensuing discussions. Modeling is another indicator of effective mentoring; however, the modeling consists of "wondering about teaching" discussions wherein the mentor verbally proposes possible teaching scenarios to the novice.

Feiman-Nemser (2001) depicts a view of the "possible" in mentoring rather than the "probable". Educative mentoring is practice-centered and inquiry-oriented in its professional development. It includes assisting the mentee with situational adjustments, technical advice and emotional support while not losing sight of long term goals for teacher development. Although this notion is not subject-specific, it is embedded within numerous articles pertaining to mentoring within elementary science (Appleton, 2008; Gustafson et al., 2002, Hudson, 2004, 2005; Hudson et al., 2005; Koch & Appleton, 2007). Educative mentoring demonstrates ideas of effective mentorship which can be contextualized to elementary science since it calls for subject-specific mentoring as a means towards promoting novice learning.

Mentoring in Elementary Science

Within the educational literature, generic mentoring delineates effective methods pertaining to the practice of mentoring (Mullen, 2005). However, specific mentoring can differ from subject to subject. Feiman-Nemser (1996) suggests discrete differences exist in pedagogical knowledge from one subject to the next emphasizing that mentoring must "address content-related issues in content specific terms" (p. 42). For the elementary science mentor relaying that specific pedagogical content knowledge (PCK) becomes a key practice in effective mentorship. The purpose for exploring the literature is to identify what these effective mentoring practices look like when impacting positive change within a novice's professional development. Employing the five-factor mentoring model (Hudson, 2004) with the embedded notion of educative mentoring became a lens for filtering the literature because this offers the most efficient identification of mentoring practices within elementary science. Additionally, these notions are foundational in constructing the conceptual framework and help outline the guiding questions of the present study.

The literature pertaining to mentoring within elementary science is alarmingly narrow. Utilizing multiple Internet search engines (Google, Google Scholar & Yahoo) and university databases (Academic Search Premier, Eric, Primary Search, & Professional Development Collection) as well as perusing literature references of published articles until a point of saturation is reached, relinquishes a total of fifteen articles. Of these fifteen articles, six are written by one author whose main focus is on the five-factor mentoring model (Hudson, 2004). Although a few articles rely on quantitative methods, the predominant research methodology represented in the literature is qualitative in nature. When the aggregate of articles are analyzed in order to integrate and generalize the findings, three categories emerge. Mentoring practices are conducted as either teacher to teacher initiatives, or through university/elementary teacher dyads, or as an instrument utilized for assessing effective practice.

Teacher to Teacher Initiatives

One of the earliest pieces of literature discussing mentoring as a teacher to teacher initiative is in *The Journal of Elementary Science Education*. The authors, Shapley and Luttrell (1992) seek to reveal the effectiveness of a mentoring model project funded by the National Science Foundation (NSF). This model is indicative of a response to science educational reform advocating the use of hands-on science as the predominant mode of instruction for elementary school science. Shapley and Luttrell hypothesize "if teachers have a role in the knowledge to facilitate changes" in school science, then they "can create and maintain change in teaching science" (p.1). Mentoring is a preferred method for supporting these changes within teacher practices.

In their investigation, Shapely & Luttrell (1992) purposively select 28 mentor teachers based on NSF criteria which include mandatory attendance at all inquiry, hands-on workshops plus nominations by school administrators. These K-5 mentors are trained over a period of several summer sessions in use of hands-on science investigations. From this training, they wrote 72 hands-on science lessons for use in their respective grade levels. This launches a series of three Saturday workshops conducted by the mentors aimed at assisting K-5 teachers with science instruction. In order to evaluate the effectiveness of these workshops, the researchers administer a pre/post questionnaire for all participants (n= 96).

Shapley and Luttrell (1992) indicate significant changes in teachers' overall attitudes when examining the total pretest mean of 57.95 and the total posttest mean of 63.07 ($p < .001$). They suggest participation in the Saturday workshops conducted by the 28 mentors positively impact the elementary teachers' science efficacy and understanding of science. They attribute this to the following mentoring practices: "familiarizing teachers with science processes, conducting appropriate hands-on activities for teaching those processes, and immediately putting the activities into practice in the teachers' own classrooms" (p.11). Shapley and Luttrell argue for the collaborative efforts of mentor/mentees in improving science practices; however, due to the nature of their quantitative study an in-depth examination of effective practices is missing.

When discussing specific mentoring practices that promote effective elementary science instruction, much of the literature presenting teacher to teacher initiatives is vague and lacking details. For example, Feldman, Campbell & Lai's (1999) study utilize a cross-level mentoring strategy which pairs high school science mentor teachers with elementary teachers in order to promote professional development opportunities featuring the teaching of physical science. Data are collected through two surveys, one accessing teacher confidence levels in teaching science and the other is a comprehensive survey retrieving information about amount of time for science teaching as well as perceptions of students' learning. Analysis reveals statistical significance ($p < .01$) for both surveys. The success of the program, according to the authors, is from the utilization of hands-on science activities by the mentors combined with administrative support over a year long period. With the exception of a description of the hands-on science activities, the authors fail to mention other effective mentoring practices that may contribute to the success of their study.

Focusing on a different mentoring issue but still relaying modicum notions of effective practice, Jarvis, McKeon, Coates, and Vause (2001) conduct a study of 64 teacher mentors and

26 trainees from two participating teacher training institutions. Challenging the supposition that virtually all mentoring is generic, the researchers gather data for the study from pretrial questionnaires of teacher experience, observations of a one-day training for the teacher mentors, observations of two non-structured and one structured interaction between mentors and mentees, individual interviews and group discussions. Findings of the research indicate positive changes in some teaching practices for the mentees with a great emphasis on the specific science PCK received from their mentors. These novices felt they had gained how to conduct a good science lesson from observing their mentors in action.

However, it is the discussions between mentor and mentee that are indicative of problems within the study. Through specific guidelines set up by the researchers (Jarvis et al., 2001), the mentor teachers are assigned a checklist as an evaluative tool and as a starting point for conversations about the protégé's science lesson. These conversations are noteworthy because they indicate an ineffective mentoring practice. When the mentor teachers conduct "lesson debriefings" in order to "inform the trainee about their view of the lesson", the mentees become "defensive and question the mentor's judgment" (p. 16). The collaborative sharing described by Feiman-Nemser (1998) is a missing element. Although the checklists provide a guiding framework for the teacher mentors, they did not promote a mutual sharing and may contribute to power differentials within the mentor/mentee relationships.

In an extensive study pairing beginning teachers with elementary science mentors over a two year period, Pickett and Fraser (2002) examine the program's effects on student achievement and attitudes as well as beginning teachers' science efficacy. The mixed-mode methodology yields impressive amounts of data from which only a small amount pertain to specific mentoring practices. These practices are indicated through focus group discussions that initially identify the beginning teachers' mentorship preconceptions. At the onset of the study, the new teachers voice concerns about the evaluative role of their assigned mentors. And yet, by the end of the two years, the beginning teachers' modified perspectives about mentoring include the notion of collaborative efforts between mentor and mentee. As one mentee explains, "It was totally opposite from what I expected because it seemed like my mentor was learning right along with me. I learned so much from her, but it was a give and take situation" (p. 36). This practice is identified in Feiman-Nemser's (1998) description of a mentor as an "educational companion" and is echoed but not elaborated in the discussions of Pickett and Fraser (2002).

Of the articles focusing on mentoring as a teacher to teacher initiative, Gustafson, Guilbert and MacDonald (2002) illuminate several effectual practices for mentoring in elementary science. The authors describe the nature of their study as a limited mentoring experience since the 13 beginning teachers only interact with their mentors during one university seminar and two half-day school visits. Data collection occurs through the use of pre/post interviews and the written, reflective journal entries of the novices.

According to Gustafson et al. (2002), the extent of mentoring transpires within the context of classroom visits. Modeling, as an effective mentor practice, is reported by the beginning teachers as a helpful way to garner "good tricks and management of things" (p. 286). The mentees are able to observe the organization of science lessons, supervision of resources and student groups as well as the use of higher-order questioning skills for eliciting student understanding. The authors indicate the conversations with mentors assist mentees with particular assessment strategies and understanding children's skill and attitude development in elementary science. It is suggested these discussions enhance protégés' pedagogical content knowledge. Finally, the practice of positive, proactive personal mentoring through helpful attitudes, generosity, and a willingness to conduct sustained conversations contribute to a constructive experience.

University/Elementary Teacher Mentoring Dyads

Within the mentoring literature focused on elementary science, several articles describe mentoring dyads composed of pre-service or in-service teachers as mentees and university professors as mentors (Appleton, 2008; Katz, Sadler, & Craig, 2005; Koch & Appleton, 2007; Schavarien & Cosgrove, 1999). Although there are fewer of these studies, they tend to provide a thick and richer description of effectual mentoring practices within elementary science.

Katz, Sadler, and Craig (2005) focus on the impact of mentorship when early childhood interns are paired with university science professors. These science instructors had pre-K-12 experiences in several science disciplines and act as mentors when assisting the interns to develop and implement a unit of science instruction. The total number of participants is eleven dyads. The researchers utilize a mixed-mode research methodology by relying on open questionnaires, focus groups involving the mentors, and interviews of mentees, science mentors, and classroom teachers.

Numerous effective mentoring practices are listed by the researchers when describing the actions of the science mentors. In addressing system requirements, the mentors review general ideas and lesson plans and then assist the mentees with applying state and national standards. Through explanation and modeling, the science mentors demonstrate hands-on science activities related to units of instruction. And in an effort to promote science PCK, the mentors clarify and integrate concepts into the curriculum of the mentee's science unit.

Despite early childhood teacher candidates' positive perceptions of the mentoring experience, Katz et al. (2005) determine the science units produced by the protégés are not of "high quality". Several reasons are cited to explain the lack of impact on mentee's science learning and teaching. They acknowledge time constraints on the part of the early childhood interns due to demands within their course schedules. This did not allow extended time for mentoring interactions that assist the building of trust. Combined with the notion of trust is a concession due to "constructed" roles surrounding mentor/mentee relationships. The perceived hierarchical position of the science mentors as professors, according to the authors, did not lend itself to the necessary sharing and collaboration needed to promote novice learning. Perceptions of hierarchy, rank and status are issues adversely affecting other mentor studies (Colley, 2002; Sundli, 2006).

In another study illustrating a teacher mentee and university professor mentor dyad, Schavarien and Cosgrove (1999) present the findings of a year-long project within a suburban Australian elementary school. The mentor project consists of ten workshops presented by one university professor (Cosgrove) while the other university professor (Schavarien) provides mentor support through modeling of classroom science lessons, providing resources, and cultivating conversations about practice. The total number of teachers involved within the project is not revealed because the authors choose to focus on one participant's "significant changes in ideas about learning and teaching science" (p. 342).

Descriptions of effective mentoring practices exhibited by Schavarien include the building of trust within the mentoring dyad. The authors attribute this to the situated-learning context and the length of time for the study as well as the mentor's accessibility when initiating and sustaining conversations about practice (Schavarien & Cosgrove, 1999). Trust is a key attribute for the successful building of a mentoring relationship (Hudson, 2005; Norman & Feiman-Nemser, 2001), while sustained, reflective conversations between mentor and protégé allow the mentee to view "her own teaching and her learning to teach in the same terms" (Schavarien & Cosgrove, 1999, p. 327). Consistently throughout conversations between the pair, the mentor enacts the roles of guide and reflective coach. As a result of the project, Schavarien and Cosgrove indicate the mentored learning and teaching approach is successful in amending science PCK within the participant teacher.

Given possible complexities when affecting an individual's PCK, Koch and Appleton (2007) advocate the use of "cooperative teaching frameworks with mentors who are recognized experts in these areas of knowledge" (p. 211). These "frameworks" subsist of a mentor known for his expertise and a teacher mentee participating within the meaningful context of the classroom. In a ten week case study of two sixth grade teachers in a private Australian school, Koch and Appleton seek to identify pedagogical changes in elementary science when university science educators engage in one-to-one mentoring of elementary teachers.

The mentoring occurs in three ways. Semi-formal small group activities at the beginning of the study involve a physical science workshop emphasizing science activities and content related pedagogical knowledge. The researchers (Koch & Appleton, 2007) take advantage of interactions within the workshop to initiate relationships with participant teachers. The purpose of this mentoring practice is to begin to build a level of trust in order to minimize "potential tensions and confusions" due to the authors' "dual roles as mentors and researchers" (p. 213). The second form of mentoring is collaborative planning of an inquiry-based science unit which is designed initially in the workshop but modifies as the teachers' implement instruction. Through this form of mentoring, the researchers continue to build trust by developing a relationship that allows mentees to be co-researchers in the process. In addition, through collaboration, the mentors are able to address specific concepts related to the unit that reflect national science standards thus addressing system requirements for instruction. The third form of mentoring occurs as the researcher co-taught science lessons with the elementary teachers. In this way, the mentors are able "to model theory building and the sharing of ideas in pairs" (p. 225).

Through their qualitative case study design that collects data from pre/post interviews, observations, field notes and the Draw a Science Teacher test, Koch and Appleton (2007) determine three levels of outcomes from the study. The first is a provisional outcome including a newly developed unit for instruction which is important but does not necessarily indicate modified teaching practices. The second level is motivational and attitudinal outcomes which suggest an increased enthusiasm for implementation of new ideas. Finally, first order outcomes relate to the development of new knowledge and skills and deeper scientific understanding within the mentee. Through the mentoring process combined with new knowledge and an inquiry approach to science teaching, the authors indicate "the potential for developing new teacher strategies is realized" (p.228) based on the observed modified practices of the participants.

In a later study, Appleton (2008) conducts "a post hoc analysis" of his role as a mentor in an attempt to identify effective practices in elementary science mentoring. Appleton uses two case studies from two consecutive projects in a series. He concedes to a built-in bias because the two featured mentees are willing participants who have "demonstrated considerable, lasting changes in their science teaching practices" (p. 529). Through the qualitative case study design, data are collected from interviews, field notes, planning documents and videotaped lessons of one teacher participant.

From his analysis, Appleton (2008) robustly claims, "all changes in (science teaching) practice are directly attributable to the mentoring" (p. 530). Using the same procedures from the mentoring study by Koch and Appleton (2007), Appleton conducts a workshop, co-plans an instructional science unit with mentees, and then participates in its implementation through a co-teach model. Key differences within the later study are Appleton's detailed descriptions of the cooperative planning process with each teacher participant. He discloses, "Our planning included identifying and selecting suitable learning experiences for the children; sequencing these so they formed an effective scaffold for the children's learning; showing how to give the children ownership of the work; asking probing questions to identify their existing and developing ideas; suggesting explanations, analogies, and models that might help the children reach a desired understanding; challenging children's misconceptions and conclusions; and assessing the children's learning" (p.531).

Effective mentoring practices exhibited within Appleton's study (2008) are his commitment and enthusiasm for the mentoring process. Beyond the initial workshops, his classroom visits are at times bi-weekly and include interactions between students and teachers that promote sustained conversations about practice. He discusses the need for a mentor to have well developed interpersonal skills in order to conduct these conversations and cultivate the attitude of a "critical friend". When commenting about the mentoring relationship, the participants admit to new ways of thinking about the teaching and learning of science that result from their observations of Appleton's teaching or his conversations. According to Norman and Feiman-Nemser (2005), this is a form of educative mentoring exhibiting a blend of "showing and telling, asking and listening in ways that promote new teacher learning" (p. 680).

An Instrument to Measure Practice

Instead of a qualitative method investigating mentoring experiences, Hudson, Skamp, and Brooks (2005) approach the topic through the creation of an instrument to determine the quality and degree of specific mentoring in elementary science. Entitled "Mentoring for Effective Primary Science Teaching" (MEPST), the survey measures pre-service teachers' perceptions of their mentoring experience within elementary science. The questions from this instrument demarcate five key attributes for mentorship which may aid a mentee's development of effective elementary science teaching strategies. Through a response to the survey, the researchers are able to surmise the extant of viable mentoring strategies specific to the subject of science.

Utilizing a literature base, preliminary investigations and pilot tests, the initial hypothesized model is analyzed with a structural equation modeling technique. Results indicate the percentage of fit better than the null hypothesis. From this venue, Hudson et al. (2005) administer the survey to 331 (284 female, 47 male) preservice elementary teachers within nine Australian universities. The participants have completed at least three block practicums; however, the number of science lessons taught by the mentees during their practicums varies considerably. Approximately 75% of the mentees have taught three or more lessons, while the remaining individuals have taught one or none. Little descriptions of the mentors associated with each mentee are provided within the study except in relation to perceptions noted from the survey.

Analysis of the survey indicate correlations and covariance's of the five factors are substantial and significant ($p < .001$) (Hudson et al., 2005). Cronbach alphas for each key factor, "personal attributes (M= 3.14, SD= 1.08), system requirements (M= 2.29, SD= 0.93), pedagogical knowledge (M= 2.76, SD=1.01), modeling (M=3.09, SD= 1.07) and feedback (M= 3.14, SD= 1.11) are .93, .76, .94, .95, and .92, respectively" (p. 667). Hudson et al. posit the degree of mentoring in elementary science teaching varies considerably; however, the MEPST instrument contributes toward the conceptualization of a five-factor mentoring model and becomes a means by which mentoring practices are made explicit. In addition, the researchers assert the instrument may be helpful in assisting mentors to develop effective practices in elementary science mentoring.

In an earlier piece of research, Hudson (2004) proposes a theory and model for effective mentoring in elementary science that reflects the five factors. Combined with the findings from MEPST research, he continues to refine his theoretical constructs (Hudson, 2005, 2007). He contends that "generalist elementary teachers in their roles as mentors will require specific mentoring strategies linked to the five factors", if effectual mentoring is to occur in elementary science (Hudson, 2004, p. 144). The mentor's roles within these factors can frame the mentee's teaching experience in constructivist ways since the mentor scaffolds, facilitates, and coaches the mentee towards a level of proficiency in science teaching (Hudson, 2005). This notion is akin to Feiman-Nemser's (1998) description of the educative mentor in which mentees are perceived as learners in the process of developing their craft. Hudson (2007) also notes mentor education is currently inadequate for developing such specialized skills. If mentees are to receive equitable mentoring in specific content areas, then mentors need to be educated in mentoring skills for specific subjects.

Hudson's admonishment for further mentor training in specific subjects is underscored in a later study. Hudson, Usak & Savran-Gencer (2009) administer the MEPST survey to 211 (117 female, 94 male) preservice teachers from three Turkish universities. Within this group of preservice teachers, 75% have completed six science method courses, 85% have participated in three or more block practicums, and 75% have completed four professional classroom experiences.

Results from the survey indicate each of the five factors as highly significant ($p < .001$). However, the areas of pedagogical knowledge and personal attributes are not clearly perceived by the mentees. Only 17% of the mentees report their mentors employing reflections as a means of improving science teaching practices. In addition, less than half the mentees report their mentors assisting them with management and implementation of science lessons. Hudson et al. (2009) suggest that despite the strong positive responses within 25 out of the 34 responses, further direction and training for mentors is needed if the development of a mentee's science teacher knowledge and skills are to occur.

Results of the survey underpin Hudson's (2004) mentoring model and serve to further clarify what effective mentoring practices within elementary science look like. Each factor within the model is quantified and statistically analyzed validating the importance of certain mentoring behaviors. From this venue, the present study utilized a similar format of questions as a means of eliciting participants' responses since these types of questions statistically reveal evidence of effective mentoring behaviors through the five factors (Hudson et al., 2005). Identification of key practices for effective mentoring is critical for the development of positive, proactive mentoring in elementary science (Hudson, 2004, 2005 & 2007). These key practices will be presented within the next section.

Five Factors for Effective Mentoring

The mentoring model developed by Hudson (2004) and further elaborated on by Hudson, Skamp and Brooks (2005) delineates five factors for effective mentoring in elementary science: personal attributes, system requirements, pedagogical knowledge, modeling and feedback. Embedded within the model is the notion of educative mentoring which is “mentoring that helps novices learn to teach and develop skills and dispositions in order to continue learning in and from their practice” (Feiman-Nemser, 1998, p.61). This is the only model within the literature to define practices specific to elementary science in order for mentors to positively impact novice learning and development. It helps to provide structure for what good mentoring practices look like and became the foundational ideas within the present study’s conceptual framework.

Emotional support is cited as one of the strongest needs of beginning teachers (Hargreaves & Fullan, 2000; Whittaker, 2000). Although nurturing represents an important aspect of mentoring, other personal attributes are of equal value (Feiman-Nemser, 1998). In a year-long study of two mentor/student teacher pairs through an alternate master’s program at the University of Georgia, Stanulis and Russell (2000) seek to understand how individuals make sense of their roles in a mentoring relationship. The initial period of the relationships entails a mutual sharing and building of deep respect through a process of observing, questioning, and participating. The types of interactions necessary to build trust center on the concept of “constructing knowledge” versus “giving knowledge” (p. 12) illustrating a respect for the knowledge a protégé brings to the relationship as well as the mentor.

As the mentor/mentee relationship develops, it is important for the mentor to acknowledge her own values and perceptions about teaching and learning (Stanulis & Russell, 2000). The mentor needs to be flexible within interactions in order to assist the mentee in connecting new ideas to existing ones. In addition, mentor coaching, using familiar language and explicit expectations promote mentee confidence. Feiman-Nemser (2001) posits mentors need to have "a respect for novices as individuals in the process of developing" combined with willingness to consider their "own practices in the light of relevant knowledge". Hudson (2004) suggests these personal attributes facilitate a mentee's development of teaching practices since there is willingness by the mentor to support and encourage the mentee.

Providing technical assistance is another key factor in effective mentoring. Hudson (2004) describes system requirements as the aims, goals, and related school policies that provide "uniformity and direction for implementing primary science education" (p. 142). He posits it is critical that mentors are familiar with the subject content and how it can be implemented in classroom activities especially within the framework of educational directives. Jarvis et al. (2001) and Shea and Greenwood (2007) advocate outlining a school's science curriculum and current district policies in order for the mentee to comprehend how these "system requirements" are to be practiced within the school setting.

Combined with these system requirements, an enhanced level of pedagogical content knowledge (PCK) in the area of elementary science is another factor promoting effective mentoring. Appleton (2008) notes low teacher efficacy, within elementary science, can be attributed to several issues; the most important is limited knowledge of science subject matter. In two case studies of a professional development program for elementary teachers mentored by a university professor, Appleton determines the teachers are better able to access science content when needed and combine it with other forms of teacher knowledge in order to generate appropriate science lessons. Within his conclusions, Appleton stipulates the mentor as an expert source of knowledge for the mentee in “curriculum (especially new curriculum and working from outcomes), science content, science PCK, general pedagogy and assessment” (p. 538).

According to Hudson (2004) science PCK is the primary reason for providing mentorship since it is the mentor’s knowledge of how to teach that can enhance the mentee’s comprehension of applied teaching practices. Gustafson et al. (2002) underscore this notion by suggesting protégés not only learn “good tricks and management things” (p. 143) such as a variety of ways to teach science vocabulary and use of science logs but how to organize the teaching of science, assess student knowledge, and integrate science into other subjects. Because of a mentor’s science PCK, she is better able to assist the mentee in improving teaching practices. In addition, a pedagogical philosophy of teaching science can be developed through mentor/mentee discussions of various viewpoints about the teaching of elementary science (Hudson, 2004).

It is this critical and specialized knowledge that experienced teachers have that help mentees to understand what their students need in order to build conceptual development. Loucks-Horsley et al. (1989) suggest the sharing of expertise as the core of mentoring. Through sharing, mentoring can become a “think aloud intellectual activity” in which mentor and mentee discuss knowledge, “ways of thinking”, and “processes of inquiry” (Feiman-Nemser, 1998, p. 69). Schmidt (2008) admonishes mentors “to spend time observing and listening very carefully” to their mentees as well as “comparing what novices say with their observed teaching practices” (p. 646). Hudson (2004) also advocates communication as a means of developing “pedagogical self-efficacy in the mentee, and consequently, autonomy in teaching practice” (p.143).

Another key factor in effective mentoring is modeling. Schmidt (2008) suggests increased self-confidence in mentees as they observe the mentors’ teaching practices. Since mentors are defined as experts, modeling technical aspects of teaching provide protégés with explicit guidance which underscores self-assurance. Feiman-Nemser (1998) proposes a collaborative style of modeling in which mentor and mentee showcase individual styles. Participation in this manner provides a more meaningful practice and suggests the image of the “joint work” of teacher mentoring.

Displaying enthusiasm during lesson planning and implementation as well as in a rapport with students are other components to modeling (Hudson, 2005). This includes the discourse used by the mentor when modeling science lesson planning since this needs to be consistent with current science education in order to assist in the scaffolding of a mentee’s professional development. Appleton’s (2008) two case studies suggest the willingness of the professor to model his approach of teaching science in a “think aloud” format contributes to modified teaching strategies within the two mentees.

The fifth factor for effective mentoring involves feedback. Moberg (2008) argues that all learning requires effective feedback that is “accurate, diagnostic, and as timely as possible” (p. 96). Experience did not necessarily translate into expertise, therefore feedback that allows for reflection is most effective in assisting a mentee to examine his/her teaching practices.

Schavarien and Cosgrove (1997) illustrate this concept through a year-long study of a school based education project which includes sustained mentoring within elementary science classrooms. The case study depicts one teacher's changing ideas about the nature of her teaching and the role of her mentor in supporting that change. Primarily, the assistance of the mentor was in accompanying the mentee to discern effective practices through a generative teaching pedagogy. The feedback occurred through multiple and numerous conversations that initially started at the end of the day after a lesson was taught but then began to occur during the day and within the lesson presentations. As the mentee gained a level of trust with the mentor, she began to test her new approach to learning and sought supportive teaching strategies.

Schmidt (2008) suggests that sustained mentor feedback, which is depicted in the aforementioned case study, is a critical factor in helping a protégé to meet the demands of teaching. Hudson (2004) contends the mentor's willingness to "provide constructive feedback" (p. 143) is a means toward assisting a mentee to monitor teaching practices and contribute to positive teacher efficacy. One component attached to the factor of feedback is flexibility on the part of the mentor. Helping new teachers "get inside the practical and intellectual demands of teaching" may sometimes focus the feedback through "reflective conversations" while at other times, the feedback may be comprised of a direct telling and asking (Norman & Feiman-Nemser, 2005, p. 695).

The factors for effective mentoring in elementary science are made explicit within the model designed by Hudson (2004). Although these factors could be applied to mentoring in other subjects, it was the focus on elementary science, an area of noted weakness for many teachers (Appleton, 2008; Duschl, Schweingruber, & Shouse, 2007; Kock & Appleton, 2007; Hudson, 2005; Rowell & Gustafson, 1993), which provide a conceptual framework for this study. It also underscores the purpose which was to explore and describe effective mentoring attributes within elementary science. Reliance on these factors as guides of what effective mentoring should be helped the researcher to frame interview questions and examine data.

Summary of the Literature

In today's education climate, teaching science presents a complex picture of incorporating conceptual, epistemic, and social domains (Duschl, 2008). With new advances in the learning sciences and science studies contributing to science education, elementary teachers are required to take advantage of more complicated teaching methods accompanied with in-depth content knowledge. For example; leading students towards current scientific ideas pertaining to methods of heat transfer requires the utilization of numerous hands-on activities and demonstrations as well as a clear understanding of students' possible misconceptions. From this point, engaging students in a manner that allows for generation of their ideas can then be used to assist them with more accurate understandings of conduction, convection, and radiation. Old methods of teaching which simply employ a textbook and some worksheets does not align with new ideas about how science should be taught, and the main brunt of modifications due to reform are shouldered by teachers since it impacts classroom practices (Smith & Southerland, 2007). This is not an easy undertaking for the novice or even the veteran teacher. From this venue, the first proposition within the literature review was formulated which was elementary science has been impacted by reform movements which have affected classroom practice.

The second proposition addressed the interrelationship between elementary science reform and professional development opportunities. These professional opportunities are first initiated at the level of higher education when most pre-service teachers, trained as generalists, did not receive intensive subject-specific instruction in elementary science. As an individual enters teaching, professional development needed to encompass new reform becomes more "learning by doing" than intensive study from a singular source (Loucks-Horsley et al., 1989). Notwithstanding, mentoring is viewed as a form of individualized professional development since it allows for a situated learning context (Norman & Feiman-Nemser, 2005; Putnam & Borko, 2000). This learning context offers the possibility for reform-minded perspectives about teaching and learning (Wang & Odell, 2002).

Mentorship can vary depending on the institution and the individual, both of which are affected by cultural perspectives concerning these types of relationships. This notion became the third proposition of the literature review. If mentoring is perceived as a "change agent" for educational science reform, then previous notions about the role of mentors and their interactions need to be discarded in order to incorporate mentoring as an integral component of school culture (Hargreaves & Fullan, 2000). One cultural perspective of mentorship reflected in numerous research articles is the notion of educative mentoring (Feiman-Nemser, 1998).

Focusing these ideas in the area of elementary science created the fourth proposition which examined specific, effective practices of mentorship in this area. However, the number of studies examining elementary science mentoring (n= 15) are dramatically few when compared to mentoring in science at the secondary level and much less when compared to generic mentoring. Even the National Science Teachers Association's text entitled, *Science Teacher Retention: Mentoring and Renewal* (2003), deals exclusively with issues related to the induction and retention of secondary science teachers.

Those studies aimed at elementary science mentoring are predominantly qualitative and, for the purpose of the review, were sorted into three categories: teacher to teacher initiatives, university/teacher mentoring dyads, and an instrument for assessing practices. The goal of the literature review was to integrate and generalize these articles in order to determine effective mentoring practices in elementary science and create a conceptual framework by which the study could be focused. Identification of these practices is deemed critical if a mentor chooses to positively impact a novice's professional development. Recognizing what an effective mentor does could inform those teacher leaders who mentor protégés in elementary science. With the exception of Hudson's (2004, 2005,& 2007) and Hudson et al. (2005) research, those articles utilizing quantitative measurements are often vague and hard to elicit details pertaining to effective mentoring practices, while the qualitative studies tended to provide richer, descriptive pictures of mentorship.

In an overall examination of articles, themes noting effective mentoring practices in elementary science were revealed. Effective mentoring involves certain character traits such as willingness to help, availability, respect, and trust building. These traits are intertwined with the mentor's expertise in relaying science pedagogical knowledge and science content knowledge in a manner promoting reflection within the mentee. Modeling of key practices utilizing "think aloud" strategies and sustained conversations about practice are two other recurring themes. These themes are reflective of the five-factor model as well as Feiman-Nemser's (1998) conceptualization of educative mentoring and became the fifth proposition within the review. In describing the personal attributes of a mentor teacher, Hudson (2005) reports the need for an individual to be both knowledgeable about her craft and emotionally supportive of the novice. Feiman-Nemser (1998) incorporates psychological and instructional support in her descriptions of an effective mentor but adds ideas that include the mentee as a learner who constructs and reconstructs knowledge.

In analyzing the literature, an illumination of effective mentorship within elementary science education was explicated through five propositions. Influences via reform movements were revealed to also impact professional development opportunities. Mentoring as a form of professional development was further scrutinized for effective practices specific to elementary science. Identification of these practices as a means towards positively impacting teacher behavior further underscored the rationale of this study. In the next chapter, the methodology will be delineated through an explanation of the research method, participant selection, data collection and analysis strategies.

CHAPTER THREE- METHODOLOGY

The purpose of this study was to explore and describe the perceptions of several elementary science mentors and their mentees within one school district utilizing a five-factor mentoring model. The mentoring model ascribed by Hudson (2004, 2005, & 2007) and Hudson, Skamp and Brooks (2005) delineated five factors for effective mentoring: personal attributes, system requirements, pedagogical knowledge, modeling, and feedback. This model combined with the embedded notion of educative mentoring composed the conceptual framework for the qualitative case study design and drove the research questions and analysis. The following questions were foundational to the investigation: (1) what was the role of an elementary science mentor? (2) How did elementary science mentors' perceptions of their practices relate to the five-factor mentoring model? (3) How did the mentees perceive the practices of their mentor in relation to the mentoring model?

Choosing the Research Methodology

Quantitative and qualitative approaches to research differ in many ways, each with its own unique features. While both methods allow for description, qualitative research focuses primarily on the kind of evidence that will enable a researcher to understand the meaning of what is going on (Gillham, 2000). The nature of this study was descriptive and was conducted as a qualitative investigation due to its examination of one small social unit which was bound by the mentor's and mentee's descriptions of the mentoring experience within elementary science. Yin (2000) suggested the case study as a preferred means of dealing with content that had "operational links needing to be traced over time" (p. 6). The intent of the study was to explore how mentors and mentees perceived and described mentorship through individual and shared experiences. These perceptions "within a scenario that allows for no control of behavioral events" (p. 6) reflected the "operational links" described by Yin (2000) in which relationships were built over time. As a result, the case study was chosen as the most effective means towards answering the research questions.

Participant Selection

All mentors and mentees were selected within Brevard County, Florida. In comparison to other school districts within the area of central Florida, Brevard County is moderately small with a total of 58 elementary schools, 16 middle schools, and 15 high schools. The overall population of residents within the county remains relatively stable with a fluctuation of 12.7% individuals between the years of 2000 and 2008 (US Census Bureau, 2009). This was also true of teacher transfer rates, with a minimum of teacher fluctuations per school.

For the purposes of this study, which was to explore and describe the perceptions of elementary science mentors and their mentees, participant selection was based upon a representation of effective mentors within elementary science education. Effective was defined utilizing descriptors of mentors outlined by the National Foundation for the Improvement of Education. Within the text, *Creating a Teacher Mentoring Program* (fall, 1999), four general areas were considered critical when describing attributes of effective mentoring. These areas were attitudes and character, professional competencies and experiences, communication, and interpersonal skills. Mentors were "highly skilled teachers… who had earned the esteem of colleagues and who possessed the confidence and 'presence' to offer counsel to other adults" (p. 9). While mentor selection relied on literature based guidelines, criterion for protégé selection was based upon a mentor's nomination of an individual who they had mentored within the past three years.

To assist the initial identification of mentors, a modified snowball sampling technique was employed. The main value of this technique was the ability to obtain respondents where there are "few in number, not easily accessed, or where some degree of trust is necessary for initial contact" (Atkinson & Flint, 2001, p. 3). In this instance, effective science mentors within elementary schools were essentially a "hidden population" due to a lack of formal recognition by the school district. Because there was a lack of recognition, the mentors were not easily accessed by the researcher.

To obtain participants for this study, a series of steps was utilized. Initially, a letter was sent to the 56 public elementary school's principals, assistant principals, and the district's elementary science resource coordinator. The letter requested nominating elementary science mentors based on mentoring criteria from the National Foundation for the Improvement of Education (see Appendix A-1). The administrators from the district (n =105) were chosen because they represented teacher educators who could assist in identifying effective mentors since they had possible knowledge of the "hidden population" (Atkinson & Flint, 2001).

Upon review of the responses, individual teachers were selected who had received two or more recommendations either from principals, assistant principals and/or the elementary science coordinator for the school district. This criterion was thoughtfully considered based on The National Foundation for Education's supposition that school administrators "often have in mind a highly skilled teacher who has earned the esteem of colleagues and who possesses the confidence and presence to offer counsel to other adults" (fall, 1999, p. 9). Given this inference, recommendations from two or more school administrators would further underscore the identification of an effective mentor in elementary science. One hundred and five queries as well as two additional email reminders per gatekeeper were sent; however, only seventeen individuals responded with names of effective mentors. Within the subset of suggested mentors, seven teachers qualified with one recommendation from either principals and/or assistant principals and the second recommendation from the district's elementary science resource coordinator.

The seven teachers were queried for participation in the study through an introductory letter. Within the letter, the individuals were asked if they had mentored a teacher (new or veteran) in science within the past three years as well as providing the names of their mentees as additional access points for the study (see Appendix A-2). Contacting each potential mentor participant included the introductory letter as well as two additional email reminders. Of the initial seven mentor teachers, five individuals agreed to participate in the study. Each person's consent for participation in the study was in accordance with the ethical standards of UCF's Institutional Review Board.

Utilizing the list of mentees provided by the mentors, a letter and two subsequent email reminders were sent requesting each mentee's participation in the study (see Appendix A-3). There were six mentees contacted since one mentor offered the names of two individuals she had mentored within the previous school year. From within this subset, only three mentees agreed to participate in the study. This allowed for three mentor/mentee pairs as well as two mentors whose information was collected to further enrich the study.

The mentees were chosen for participation as a validating component for the study as well as to provide a sense of coherence. Each mentor/mentee relationship was unique and represented a particular dynamic. Even though the focus was on capturing the experiences of elementary science mentors, by including the perceptions of mentees, a more comprehensive view of the encounters was constructed through the inclusion of additional sources of data. The rationale for using multiple sources of data was the triangulation of evidence. "Triangulation increases the reliability of the data and the process of gathering it, in the context of data collection; triangulation serves to corroborate the data gathered from other sources" (Tellis, 1997, p. 8). In addition, triangulation underscored the trustworthiness of the study since multiple data sources were used for corroboration. This not only included data from interviews but observations recorded within field notes pertaining to mentor/mentee interactions.

Description of Participants

The mentors were Caucasian females between 35 to 55 years of age and teaching at an elementary school in Brevard County during the time of the interviews. Each teacher identified herself as one of Brevard County's Science Point of Contacts (POC). This identifier signified attendance and participation in school district meetings related to elementary science curriculum. Their roles were to then relay science information at each school site. The years of experience of the five mentors ranged from 12 to 29 years. Two teachers had earned master's degrees, and three of the five were certified by the National Board for Professional Teaching Standards (NBPTS). All mentees were Caucasian females; two were in their mid-forties and one was 25 years of age. While all mentees were teaching in a Brevard County elementary school, two were experienced veterans with 7 to 15 years of experience and the younger participant with two years teaching experience.

In the following paragraphs, descriptions of each participant were included in order to provide additional insight into the role of the mentor. These depictions add a rich, detailed illustration of each person and their contribution to the mentoring experience.

Abbey- Mentor

Abbey was a veteran teacher with 13 years experience who had earned a Master's of Education degree and her National Board certification. She had been a Physical Education teacher for numerous years but desired to gain classroom experience after earning a degree in administration. As the science lab instructor for her school for the past three years, she acted as an activity teacher instructing students in science at every grade level for approximately 40 minutes per class session. Abbey described herself as proactive in helping to set up a science lab for her elementary school. Writing grants, accepting donations, as well as pulling already existing resources, she set up a science lab that served every grade level at her school. Abbey stated that she had turned to other teachers within the district in order to help her with the process of setting up her science lab. She considered these teachers her mentors since she had observed their classrooms and lesson plans on several occasions as well as held numerous conversations about setting up and running a science lab. In addition, Abbey described seeking help and support from the district's elementary science coordinator and attending several science in-services and the annual Florida Association for Science Teachers (FAST) conferences.

Abbey stated she had mentored several teachers but specifically spoke of helping two teachers through the National Board certification process, focusing on science education. It was these two individuals she had recommended for participation in the study. However, both individuals declined participation, stating their schedules did not allow time for the required interviews. Abbey stated both teachers initiated the mentoring relationship. As she recounted, "The way it started was when they would pick their children up from activity, they would start coming five minutes early to see what I was doing and how I was doing it. And then, the relationship with the two of them just extended itself to helping them with science for their National Board process and what they did in their classrooms."

Lori- Mentor

Of the five mentors, Lori had the most experience as a mentor and a veteran teacher. She had taught for 29 years and mentored teachers for approximately half that time. She was also a member of the school district's Resource and Training Cadre for elementary science education as well as a National Board certified teacher. She relayed she had been a presenter at various science meetings and workshops and assisted with the development of state science objectives targeted at adaptations for ESE students. Her mentoring experiences were numerous including working with college interns, National Board mentees, and with “some international students” as a part of the University of Central Florida’s teacher program. The core of her mentoring experiences she described as stemming from her participation as a science resource teacher for a low performing magnet school. In describing this position, Lori relayed, “My job was to be a model teacher working with the teachers and working with the grant, purchasing materials, setting up their lab, working one-on-one with the students and teachers, supporting the magnet, and making sure we were using funds correctly in the science area.” She reported working with teachers at all grade levels and with the students of these teachers; however, her greatest emphasis was on fifth grade due to the annual science Florida Comprehensive Assessment Test (FCAT).

At the time of the interview, Lori was situated within a different elementary school teaching sixth grade science in a departmentalized setting. She had been in this position for the past two years. She recounted working with a fourth grade teacher at her present school site, on “sequencing and pacing guides” and “helping with materials” in order to get the students ready for the future fifth grade FCAT. This teacher was her nominated mentee but did not respond to the letter or several follow-up emails requesting her participation within the mentoring study.

Carol and Cora-Mentoring Dyad

The first mentor/mentee pair to participate within the study was Carol and Cora. Carol was a veteran teacher with 25 years experience who at the time of the interview was teaching fifth grade. Carol described teaching science "by default" since she didn't mind the hands-on as much as the other teachers in her grade level. As Carol stated, "Is it my strength? No, it is definitely not my strength. It is something I have to work on continually. I don't have a degree in science, but I love it because the kids love it so much." Carol described a past encounter with an experienced teacher that she felt had contributed to her ability to teach science, "She (Carol's mentor) had a passion for science and she loved the space program. And so, she was the person to watch. I would go into her classroom and say, 'Okay, what are you doing now?' She would be the mad scientist with the hat on, and she was just fun. I learned a lot from her. I would ask her what about this and what about that, and she was always very willing to share her experiences." Carol admitted these previous experiences and interactions not only contributed towards her expertise as a teacher but towards her willingness to mentor others.

Carol's mentee, Cora, was a veteran teacher with seven years experience who was teaching first grade at the time of the interview. Cora shared her mentoring experiences were limited to those interactions with Carol that pertained mostly to science fair. It was Cora who initiated the relationship because she desired to network with other teachers beyond her grade level. She felt involving herself in the school's annual science fair would enable her to meet and work with different individuals. Carol and Cora began working together approximately three years prior to the study's interviews. Comments about mentorship from both individuals pertained mostly to that first year.

Kendra and Angie- Mentoring Dyad

Kendra and Angie were another mentoring dyad within the study. Kendra was a veteran teacher with 17 years of experience; she had taught numerous grade levels but had been the science resource teacher responsible for her school's science lab for the past six years. She indicated that initially science had not been a preferred subject but something she was "stuck with" while teaching sixth grade in a departmentalized setting. Kendra recounted at that time she did not have "a textbook, didn't have a curriculum, didn't have nothing". According to Kendra, having "nothing" led to "everything becoming hands-on" in her science curriculum. This developed into her present conception about teaching science which was, "My philosophy is science is taught hands-on with a very minimal amount of reading. Lots of writing, a lot of response journals, but not a lot of reading". As the science resource teacher at her elementary school, Kendra taught third through sixth grade on an activity wheel plus was a leadership chair that relayed science information to the faculty on a regular basis.

Kendra's mentee was Angie, a new teacher with two years experience who had taught fourth grade and at the time of the interview was teaching kindergarten. Angie relayed her passion for science began as a child and was extended to her work with the First Robotics Lego League. Combined with an educational background including biology and chemistry, Angie had cultivated an interest in science that she also saw exhibited in her mentor, Kendra. Angie sought Kendra's experience as a mentor when she saw the activities her students experienced while in the science lab.

Mary and Karen- Mentoring Dyad

Of the five mentors, Mary had the least years of experience (n =12). She had earned a Masters in Education from Kent State which focused on elementary science education and the National Board for Professional Teaching Standards (NBPTS) certification. She was also a member of Brevard County's Resource and Training Cadre, an area director for the Florida Association of Science Teachers (FAST) and assisted with the state's revision of K-12 earth/space science standards. Mary was the science lab instructor for grades kindergarten through fourth at her elementary school at the time of the interview. She had been in that position for the past three years.

Mary relayed numerous mentoring scenarios. She had provided trainings as a member of the district's science cadre and then followed up with school visits to encourage teachers to implement science activities. She listed many individuals, administrators, and even a group of teachers from Singapore who had sought her expertise by observing and conferencing with her. At the time of the interview, Mary was mentoring Karen. Karen was a veteran teacher with 15 years experience. She had sought Mary's expertise in the science lab when she was hired to be the science activity teacher for her elementary school. Her reasoning for seeking Mary as a mentor was to glean information about how to run a lab that would service all grade levels within a school. Although Karen had taught different grade levels for a number of years, she felt the challenges of creating lab experiences for children of diverse ages, abilities, and needs necessitated a greater degree of specific pedagogical content knowledge which she recognized in Mary.

The total number of participants for the study (n= 8) was small. There were only three mentoring dyads from which to construct a comprehensive picture of the elementary mentoring science experience. However, the researcher chose not to ignore the two mentors whose mentees did not consent for participation. This was based on the notion that "description is needed to convey what is going on" (Straus and Corbin, 1998, p.16). By its very nature, this case study was descriptive of particular phenomena which were perceptions of effective mentoring practices. By including the two mentors, additional perspectives were obtained that might produce deeper insights into the phenomena. Also, inclusion of these perspectives could promote greater objectivity within the qualitative study. As Straus and Corbin (1998) contended, "objectivity does not mean controlling the variables. Rather, it means openness, a willingness to listen and to 'give voice' to respondents" (p. 43). Additionally, as a means towards ensuring confidentiality and in accordance with UCF's Institutional Review Board regulations, pseudonyms were used for all participants within the study.

Data Collection

Based on Yin's (2000) methodology for case study research, person-to-person interviews were conducted with the identified teachers since this allowed the researcher to share another person's perception. The researcher assumed that the perceptions of others were meaningful and that these thoughts, feelings, and intentions could not be observed, thus self-reporting became the primary venue for retrieving perceptions. Data were collected through audio recordings of the individual interviews as well as observations and field notes. The interviews allowed for an in-depth, purposeful conversation related to the individual's role as an elementary science teacher and as a mentor or mentee, their personal experiences, and their perceptions of effective science mentoring practices. Two interviews per individual were obtained after each person had signed the informed consent agreement. The interviews were conducted in the teacher's classroom, or school, or for two individuals, at a local restaurant which allowed easy access for both researcher and teacher.

The initial interview for the mentor teacher utilized a structured protocol based on research questions (see Appendix B-1) and was accomplished within an approximate sixty minute session. All questions were driven by the conceptual framework for the study which employed the five-factor mentoring model and the idea of educative mentoring. Although flexibility may have been limited for relating the interview to specific individuals and circumstances, the approach allowed for comparability of responses between and amongst participants. Hancock and Algozzine (2006) suggested this type of protocol could promote a greater degree of "data completeness" for each participant as well minimizing the "effects of interviewer biases" (p. 43). In addition, the structure from this type of protocol tended to facilitate data organization and analysis.

The second interview (see Appendix B-2) reflected a similar format utilizing a combination of structured and semi-structured questions that were answered within a sixty minute time frame. Additionally, the mentee of each designated mentor was also queried utilizing a similar interview protocol (see Appendix B-3, B-4). The interview questions considered the mentee's perceptions of the mentorship experience related to the five-factor model and served as a guide for collecting information. Data collection occurred concurrently for the mentor/mentee pairs; however, interviews were conducted separately.

Although the researcher did not pilot test the questions, each interview was transcribed and then emailed to the respective teacher in order to conduct a member check. Member checking contributed to the internal validity of the study because the participant was provided the opportunity "to check for the truthfulness and accurate representation of his/her perceptions" (Hancock & Algozzine, 2006, p. 43). Of the eight participants who were emailed their transcribed interviews, five did not respond to the member check. Two teachers stated they felt encouraged by the articulation of their mentoring experience and one was concerned with the spelling of certain acronyms which the researcher checked for correctness.

Data Analysis

According to Yin (2000) every qualitative investigation should have a general analytic strategy. This will guide decisions pertaining to what will be analyzed and for what reason. For a case study, the analysis should rely on the theoretical propositions that led to the investigation. As a result, data were organized around the five-factors from the mentoring model (Hudson,

2005) as well as the role of the mentor within the mentoring dyad. Imbedded within the interview protocol (see Appendices B-1, B-2, B-3 & B-4), the questions illustrated each of the five factors: personal attributes (10 questions), systems requirements (4 questions), pedagogical knowledge (11 questions), modeling (7 questions), and feedback (5 questions) as well as open ended questions pertaining to the role of each mentor. These questions were generated from a survey designed by Hudson, Skamp & Brooks (2005) in which proportions for each question were validated using statistical analysis.

The analytic technique for the accumulated data involved a three step process recommended by Miles and Huberman (1994): data reduction, data display, and conclusion drawing/ verification. Organization of data reduction and data display of the transcribed interviews and field notes began prior to the actual interviews through the design of a two column matrix which allowed for questions within one column and the corresponding responses in the adjacent column. This form of data collection accelerated later data reduction because it allowed for the "cutting and pasting" of related responses.

Miles and Huberman (1994) posited data could be reduced and transformed through such means as "selection, summary, paraphrasing, or through being subsumed into a larger pattern" (p.23). The conceptual constructs that formed the research questions for the study became an initial "sorting" mechanism for data reduction and served as a priori codes since they were developed before examining data. Through the reliance on existing codes derived from the literature, the researcher sought to increase intracoder reliability in which consistency within a single coder is enhanced (Patton, 1990). These codes served as sets of "lenses" to view the collected data and facilitated the deductive chunking of data into six initial categories: the role of mentors, personal attributes, systems requirements, pedagogical knowledge, modeling, and feedback. Each of the participant's responses was sorted by question into one of the six categories. These responses were again sorted into two subsets of mentor responses and mentee responses.

Data display occurred as a concurrent flow of activity. Miles and Huberman (1994) advocated good displays as "a major avenue to valid qualitative analysis" (p. 11). To accomplish this activity, matrices were developed in order to create "an organized assembly of information" (p. 25). The first set of matrices were organized for data collection while the second set of matrices utilized the interview questions with responses sorted by a priori codes with subsets including mentor and mentee responses. After multiple readings of this display, the matrices were reorganized by mentoring dyads so that all responses of one mentor and her mentee were examined as a whole. The two additional mentors whose mentees did not participate were examined for their responses individually but then compared to the other participating dyads for similarities and differences. The organization of the matrices in this manner were read multiple times in order to continue the within-case analysis and note patterns related to each mentor's role compared to the conceptual framework.

Accompanied with the a priori codes, memoing occurred in the margins of the matrices or within spiral notebooks in order to note and question patterns. Through the process of memos, several points were made evident that assisted the analytical process. First, when examining the role of each mentor, the selected questions did not provide enough insight into the individual's behavior, thus the reorganization of the matrices and subsequent readings of each mentoring dyad were conducted holistically in order to get a sense of the type of role each mentor teacher enacted. The researcher asked, "What do mentors do?" within a memo and from that created a list of actions based upon data from the multiple readings. From this venue, selective coding of mentoring behaviors was conducted. The core variables for this selective coding were chosen from the literature based on the works of Feiman-Nemser (2001), and Wang and Odell (2007). The core variables included elements of the humanistic perspective, the situated-apprentice perspective and the educative mentor perspective and were coded as emotional support, technical support and educative support. These codes emerged from the constant process of reading, rereading and comparing the data. This coding schema was then used to group participant responses and field notes into three emergent themes with two overarching themes (see Figure 1).

Other memos resulted in the reorganization of matrices pertaining to the conceptual framework's five factors. The responses for each a priori code were compiled and analyzed holistically as a core variable. Notions about what modeling meant and how it was described by each participant were noted within memos as well as other ideas such as what constituted feedback within the relationship. The initial a priori codes for the five-factor mentoring model served as core variables from which emerged additional codes which were grouped into themes related to the factors. These codes contributed to a graphic interpretation within the form of a context chart (see Figure 2) that mapped the relationships among factors making up the context of the individual behaviors. The graphic design served as an outline for the writing of the analysis as well as providing additional insight into connections between and amongst factors.

Within these categories, an additional context chart (see Figure 3) was created mapping the relationships between the participants' responses and the conceptual framework of the study. This allowed for preliminary conclusion drawing and verification which is the third step and initiates the process of deciding what things mean. Miles and Huberman (1994) suggested doing this by "noting regularities, patterns (differences/similarities), explanations, possible configurations, causal flows, and propositions" (p, 24). However, they also admonished researchers against heavy reliance on these conclusions because the matrix format sets boundaries on the types of conclusions that can be drawn. This was the case for the present case study since the interview protocols were only structured towards the five factor mentoring model thus limiting possible deeper insights into the mentoring dyads relationships.

Through numerous, multiple readings of the transcripts, reliability for the study was enhanced since this occurred not only with the researcher but with an outside reader. Another graduate student was invited to follow a chain of evidence in order to determine if similar conclusions could be drawn from the data. As a first step, the researcher ensured confidentiality of all participants by utilizing pseudonyms so that the outside reader was only exposed to names of participants as presented within this study. Then the researcher presented conclusions in the form of a contextual chart (see Figure 3) to the outside reader first, followed by citations of specific quotes as they pertained to the context charts (see Figures 1 & 2). From this step, the researcher then went on to present actual participant transcripts (using pseudonyms) with accompanying field notes. The method of data collection was explained in order to inform the outside reader of consistent techniques. Finally, the researcher linked the case study protocol and initial study questions to the previous steps. The purpose of steps within a chain of evidence promoted “clear cross-referencing to methodological procedures and to the resulting evidence” (Yin, 2000, p. 105). Through multiple readings and much discussion the outside reader was able “to trace the steps in either direction” and concurred with the conclusions drawn by the researcher thus underscoring the reliability of the study.

Summary

The qualitative case study design was chosen in order to explore and describe the phenomena of elementary science mentoring. Participant selection utilized a modified snowball sampling technique resulting in five purposively selected mentors and three mentees. Each individual participated in two one-hour interviews. Interview data were collected utilizing a structured protocol; all interviews were audio taped and later transcribed. Analysis of the interviews with accompanying field notes followed the recommendations of Miles and Huberman (1994) for data reduction, data display, and conclusion drawing/verification. The findings, which were presented in chapter four, were divided into two sections: descriptions of mentoring roles and descriptions of the five factor mentoring model perceived and discussed by mentors and mentees.

CHAPTER FOUR- PRESENTATION OF FINDINGS

The purpose of the research was to explore and describe within a five-factor mentoring model (Hudson, 2004) the perceptions of several elementary science mentors and their mentees within one school district. In doing this, the researcher sought to capture the voices of both mentor teachers and mentees in gaining perspectives on key aspects of mentoring in order to fully understand the experience. Utilizing a five-factor mentoring model (Hudson, 2004) with the embedded notion of educative mentoring (Feiman-Nemser, 1998) as the conceptual framework, the case study design incorporated data from interview questions and field notes of five mentors and three mentees. This conceptual framework guided the formulation of the interview questions as well as the focus of the analysis.

The main research questions of this study were: (1) what was the role of an elementary science mentor? (2)What were elementary science mentors' perceptions of their practices in relation to the five-factor mentoring model? (3) How did the mentees perceive the practices of their mentor in relation to the mentoring model?

Presentation of findings was organized into two sections. The first section addressed the research question: what was the role of a mentor within elementary science? The second section illustrated the responses of the participants within the framework of the five factor mentoring model. It addressed the remaining two research questions by comparing responses of mentor and mentee. Throughout both sections, quotes of the mentees positively or negatively reinforced the perceptions of the mentors and underscored triangulation of the accumulated data.

Role of the Mentor

In order to ascertain what type of role the individual played within the elementary science mentoring experience, the researcher not only utilized semi-structured questions such as, "What kinds of mentoring in elementary science have you experienced? How do you view yourself as a mentor? In what ways was being a mentor hard and what is important about being a mentor?" but also scanned the whole of each interview as means of ascertaining what each person did as a mentor. Repeated readings revealed certain codes found within the literature and from which the verbatim and observational data were organized into themes.

Through examining the roles of all participating mentors, two overarching themes emerged. The commitment to the mentoring process demonstrated by the mentor's willingness to volunteer time, resources, and energy was the first theme. The second theme pertained to flexibility within each mentor's role dependent on the context of the mentoring relationship. These two themes underscored three emergent themes illustrating roles each mentor played within a relationship. These roles were emotional support, technical support, and educative support (see Figure 1). Within the context chart labeled as figure 1, the three emergent themes were grouped by column with corresponding categories under each heading. Overarching themes were above the chart. These were drawn pointing towards each other since the concepts converged together when illustrating the mentor's role within elementary science.

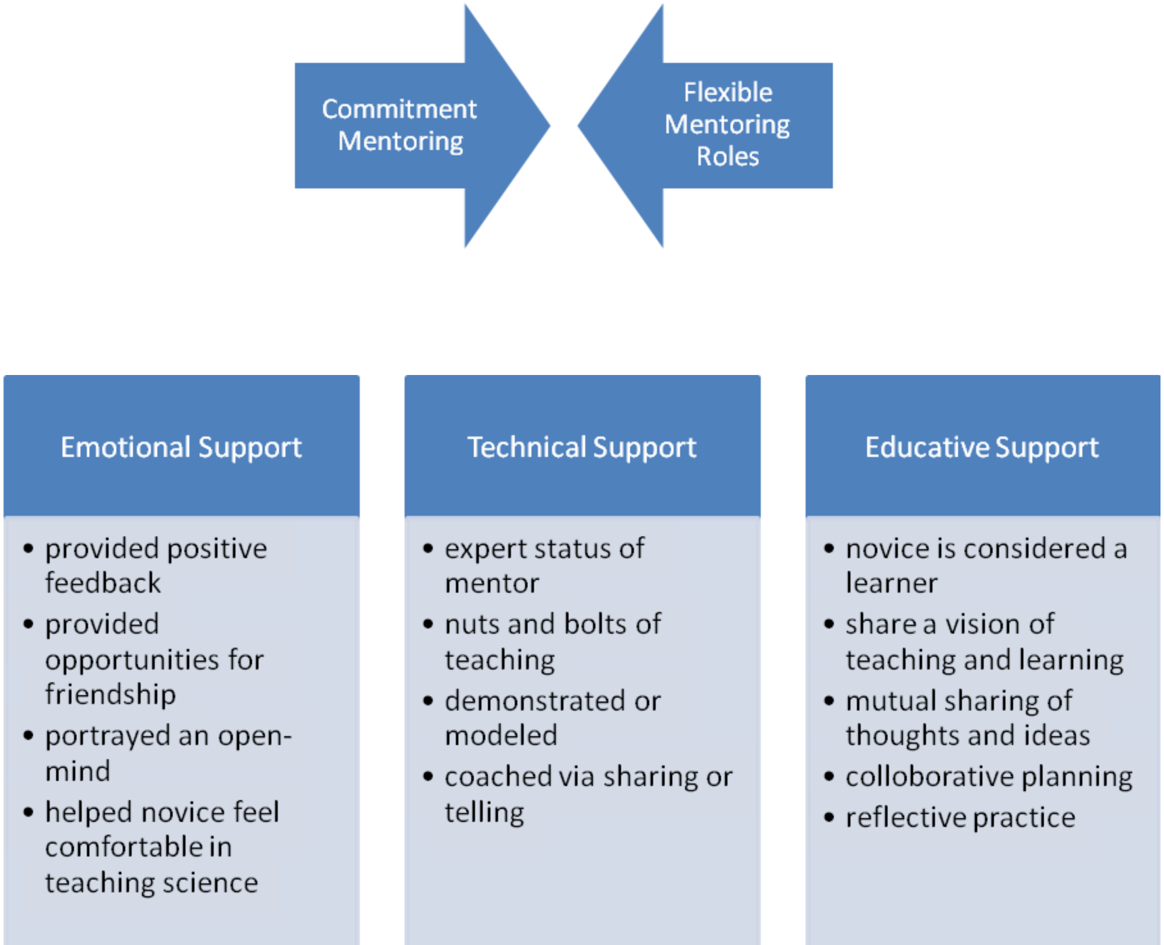

Figure 1: The Role of the Mentor

Emotional Support

The emotional support provided by the mentors was relayed through positive feedback, developing a friendship, being open-minded, and helping the novice feel comfortable with science. Positive feedback was a means by which the mentor bolstered confidence and improved attitudes. Abbey shared instilling a positive attitude helped towards increasing teacher efficacy. Karen also shared this view when discussing her mentor's (Mary) positive feedback helping to make her new position as a science lab teacher “a lot less daunting”, while Mary felt positive feedback was effective because teachers would have “a better attitude” which she noted when mentees changed facial expressions of anxiety to smiles. Angie, Kendra’s mentee, reported frequent weekly positive feedback that was constructive in nature when she relayed this anecdote, “She always made sure she tells me something positive. So, if something needed to change, she would say it very nicely and made sure we were on the same page about it. It was always positive. I cannot remember a week that did not go by that she didn’t do something positive.” Another mentor, Lori utilized positive feedback because she disdained negativity. Sometimes her feedback was reflective in nature, she shared, “Even if a teacher was struggling, we would ask them how did it go? Let them reflect on their own success and then say, ‘how can we help you and what can we do?’ in order to make it our problem and not the teachers. This way we wouldn’t put them down and they would receive support.”

The development of a friendship was another component that emerged from data related to emotional support. Within this section, five of the eight participants offered perceptions pertaining to the building of a relationship beyond mere collegial support. Abbey described it this way, “A very big component of mentoring is the relationship that you build. Sometimes you might have to meet with your mentee and not even talk about school or talk about the lesson because you might need to get to the root of the problem or the anxiety or what they are having trouble with in order to bring out the good thing.” While Cora and Carol spoke of building a friendship within their dyad, Karen admitted to “getting really close” to Mary. Mary did not offer comments in the area of friendship but Karen further explicated the nature of the dyad when she said, “It’s funny because she is almost like a boyfriend. She calls me every day… I am very comfortable in talking to her about what worked and what didn’t work.”

Of the eight participants, Lori did not offer comments nor was there a mentee available to discuss this aspect. Another mentor, Kendra, did not suggest this type of support, yet her mentee, Angie, provided these statements, “Mentoring is gaining a friend. You spend so much time together that you develop a friendship that goes deeper than just another teacher here or there. You almost become relatives, in the fact that, you know what’s happening in that person’s life. And you know what’s going on because you have spent so much time working with them one on one.”

A third aspect of emotional support was the mentor’s ability to remain open-minded. Four of the five mentors commented on this while Angie, a mentee, described an open relationship with her mentor, Kendra. She shared, “We are very open with each other about what is happening and what is not. There is nothing we can’t discuss when it comes to science. The doors are always open and we keep it that way.” Although Kendra did not comment about this, Angie’s perceptions implied her mentor’s open-minded attitude. Carol also described an open-minded stance and a willingness to try new things in respect to her mentee. Abbey suggested open communication and a respect for novices when she made this comment, “I would say, ‘Do what works for you. This is what worked for me and here’s the idea.’ They can take it and change it up a little bit and do what they need to do.”

Lori acknowledged her tolerance for differences when she relayed, “If they (mentees) are having some success, my suggestion is to maybe modify because every teacher is different. I don’t expect my mentee to come in and do it the way I do because it feels comfortable to me.” Mary further underscored this notion when she shared, “I have to keep in mind that everyone is different and to not have expectations. There are some people I have met with, they do not want to run their lab the way I do, which is fine. So, if it is different, I will talk them through it. I help them to create whatever works for them and their students…We basically fit it to their needs, whatever they needed.”

The fourth pattern that emerged within the theme of emotional support was making the novice feel comfortable when teaching science. Abbey shared, “Both you and I agree that what is important is open communication and showing support so that they (mentees) can come to you. They have to know that it is a safe place to say, ‘It bombed. The kids hated it. There was stuff all over the room.’ So, you can advise them and help them along with that.” Anxiety about teaching science and the need to make the individual feel comfortable was reverberated within other mentors’ comments. Mary exclaimed, “I have had a few people that were not happy they were teaching science. But once I showed them how to do it and how easy it was and where to go to get resources, they were not afraid anymore. There were a few teachers who hated it, but once I helped them out they are doing fine, absolutely fine.” Her mentee, Karen, echoed this support and how comfortable she felt after working with Mary. Another mentor, Kendra, also suggested this form of mentorship when she stated, “As a resource teacher here, not only was I scared to teach science, so were many of the teachers at my school. They think it’s some kind of weird animal and they don’t understand it. The mentoring that I have done was to teach teachers how to feel comfortable with science.”

While Lori and Carol did not comment in this manner, it was Carol's mentee, Cora who voiced the notion of this type of support. She began by describing Carol's availability helping her to feel like she was "never in it alone". She further elucidated, "To have someone to talk with, like a mentor, helps you to stay with what you know. Because you have someone you trust, not only as a person, but their enthusiasm, their knowledge, and their ability to talk with you so that you do not become overwhelmed."

The four patterns pertaining to emotional support were interconnected. Feedback that was positive could also be attributed to feedback that helped to make the novice comfortable due to an open-minded attitude of the mentor. A closer relationship leading to friendship was reflective of the frequent feedback and shared support and most likely underscored by a flexible and tolerant stance.

Technical Support

The second theme that emerged from data pertaining to the role of mentoring was technical support. The term technical support arose due to repeated comments from the participants about support that was viable and specific to practice. This notion reflected Wang and Odell's (2007) perspective of situated apprentice mentoring since the assumption pertains to "knowledge growing out of the context where it is used" (p. 476). Four categories were revealed within this theme: expert status of the mentor, the nuts and bolts of teaching, demonstrating or modeling, and coaching via sharing or by direct instruction.

Each mentee purposively sought out the individual mentor because of her expertise within elementary science. As Cora stated, “It was evident that she (Carol) was the science person for our school. She was also the science fair coordinator. She has always been available, approachable, willing to share, encouraging…I knew right off that she was not just the science contact person but that she really loved and knew science.” Carol’s description of her expert status was less adamant and pertained to her sharing with professional learning clubs at the school level. This type of sharing and view of the mentor’s capacity was also similar to Angie’s description of her mentor’s knowledge when Kendra conducted regular meetings with members from each grade level in order to discuss aspects of science education such as pacing or assessment. Mary and Karen, one dyad within the study, did not mention mentor expertise as a component of technical mentoring; however both described Mary’s presentations at NSTA and FAST conferences.

Lori and Kendra suggested expertise within elementary science was a necessary component of mentoring. Lori posited “showing them (mentees) that you have special skills that can enrich teaching” helped to not only “give the kids the best we have to give” but helped the novice to learn new practices and change old ideas. Kendra discussed the notion of proficiency in this way, “I think to be a mentor you have to be real passionate. You know, real sure and real knowledgeable. To be a mentor, you really have to be an expert in what you’re doing to teach somebody else. But also, that is what made you the expert, because you had to learn to teach.”

The second category within the theme of technical support emerged when the researcher observed each mentor describing some type of physical action in supporting the mentee. These physical actions were labeled "nuts and bolts" because they described an activity that was needed in order to assist the teacher with an aspect of her practice. Lori spoke of assembling all the materials for a teacher as did Kendra who said, "We will talk about where they are and where they're going. Sometimes there will be a teacher who says, 'okay, at third grade we are getting ready to do energy. What kinds of lessons could we do?' I would put together a cart for them with all the energy stuff on it." Angie, her mentee, corroborated this view but also included Kendra taking her "hands-on" through the schools resource center. Carol and Mary spoke of providing resources like books or even the names of guest speakers. In addition, Mary's mentee, Karen, described how Mary helped her "to set up a prep closet that had floor to ceiling drawers for every grade level". She admitted this action was a "saving grace" because it helped her to run the science lab more efficiently. Another mentor, Abbey, revealed times when she helped her mentees to "arrange the desks in a certain way to help the flow of traffic". Abbey also added that she helped "the ladies to set up science trays" in order to facilitate classroom management of science experiments.

Demonstrating classroom practice through modeling was another component of technical support provided by each mentor. For Lori, as the science resource teacher within the magnet school, she felt this was a crucial component when assisting novices. She stated, "That was part of the 'Primary Child' (the grant under which she worked), which was to be the model teacher and then to respond…I showed them (teachers) how to group them (students), how to call on students, how to get them into groups." Mary described modeling "how to set up a lab, how to organize it, how to run it, and how to plan for it" provided strong support for mentees who were hesitant to teach science. While Abbey felt she modeled effective classroom management but was quick to share that modeling was a means by which she aided the novice in problem solving. If something did not go well, she would model a different idea.

Since most of the mentoring experiences within Carol and Cora's relationship pertained to science fair, Carol reported demonstrating "science projects to her" and "how to set that up and use older students to assist". This situated learning was reported by Cora as beneficial in helping to "learn the ropes". Kendra, a mentor, shared this aspect in terms of all the teachers she helped. She stated, "By modeling for them, and showing them my lesson plans and talking to them about how to grab the kids' attention. Sometimes I come and model in another classroom. Especially in the primary grades because it's not one I usually do direct instruction." Angie further underscored Kendra's actions as helping "us to be where we need to be" when conducting science within the classroom.

The fourth category of technical support provided by the mentor was coaching. This coaching was in the form of sharing expertise through suggestions or by direct instruction. Examples of directly instructing the novice about state and district guidelines, questioning techniques, science lab rules and science safety, science projects and how to present to parents were provided by Lori. She stated verbally targeting areas of pedagogical knowledge and teaching techniques with the mentees and then modeling these while in their classrooms. Kendra also used direct instruction when relaying information from the state or district or "showing them the lessons and saying this is how I would do it or use it". She acknowledged, "They are not really developing their own lessons. I am kind of giving them my lesson plans." Another mentor, Abbey, shared how she allowed her mentees access to her computer desktop in order to peruse lesson plans. With this access, Abbey would tell novices her way of implementing the lesson; however, she was quick to admit that this was “one way of doing it”.

Mary described direct instruction when working with certain individuals who asked her to observe at their elementary school. She relayed, “In one case, I actually went to their school and helped them. I observed and when I saw something I would say, ‘I wouldn’t do it this way, this is how I would do it.’…If I knew there was something I would not do, then I would point it out to them when the children were not there.” However, for the most part, Mary’s technical support was more suggestive in nature. She spoke of recent communication with a novice who would be setting up a science lab at his school for the first time. She described “going over” different facets of the lab while listening to the situated needs of the individual. Her approach was to “share” what she did and how she did it. Her mentee, Karen, corroborated this perception. Karen communicated learning about science journaling, time management, and working with primary children on process skills because of conversations in which Mary shared her daily practices. This form of coaching offered ideas to the mentee as possible venues and not mandated practices.

Educative Support

The third theme to surface from data about mentor roles was educative support. This type of support was reflective of attributes described by Feiman-Nemser (1998, p.66) that helped “novices learn to teach and develop skills and dispositions which encouraged continued learning in and from their practice”. Data revealed five categories: the novice as a learner, shared vision, mutual sharing, collaborative planning, and reflective practice.

One mentoring dyad suggested the idea of the mentee as a learner. Carol described how her mentee, Cora, “learned by jumping in” and “doing the process”. She admitted to the need to let “loose of a little control” because the mentee might not “do something right”. Carol remembered this as “kind of hard to trust in her ability”, but acknowledged that Cora needed to “learn by doing”. Cora also stipulated this view in describing Carol’s ability “to wait to allow ‘it’ to happen”. The “it” were those skills and practices Cora was attempting to master.

Sharing a vision of teaching was discussed by two mentees within the study. Their mentors did not comment on this aspect. Angie described how she and Kendra were “right on” with their viewpoints about science teaching and learning. She shared, “It’s getting the children exposed to as much as possible in order to increase their knowledge of what’s out there.” Karen also recounted her discussion with Mary, “We talked often about how we are building the ground work in the lab. Starting with the simple process skills in kindergarten, pre-K for me. Building not only that vocabulary and content knowledge but also that enthusiasm and passion for science.”

Collaborative planning as a facet of educative support was mentioned by several participants. Lori shared planning with the teachers within the magnet school was a core component of her position as science resource teacher. She would then assist with the implementation of the lesson or by “going in and sitting with them (teachers) daily to see if things went right”. Mary and Karen, on the other hand, planned extensively together. Mary stated meeting on a regular basis with Karen in order to plan weekly lessons, keeping in mind the differences within their school settings. Mary shared, "Now she is at a Title One school and I'm not. So, we kind of know that she may do it one way and I may do it another way. But we discuss it, and we bang ideas around and talk about." Karen also shared this sentiment and added other reasons for differences in planning. "We would get together with our laptops and we already had all the benchmarks. We would generate and brainstorm ideas…I am strong in life science and she is stronger in physical science. We plan so well together. I love planning with her."

Another form of educative support was mutual sharing between mentor and mentee. Angie stated, "Some of the things I have done, she has picked up, and some of the things she has done, I have picked up." Although Kendra made no comment pertaining to this, Angie attributed this to her own background and her mentor's knowledge. One mentor dyad, Mary and Karen frequently noted "bouncing ideas" off one another as an expression of communal idea exchanges. Carol also echoed the notion of "bouncing ideas". She commented, "I think it (mentoring) is a great experience because not only am I sharing what I know with her but I learn from her as well. If I give her an idea, I usually get one back, too…it is give and take. Not only am I mentoring her but she mentors me as well." Her mentee, Cora, expressed admiration for her mentor's ability to articulate science concepts well.

The last aspect of support within this theme was the usage of reflective practice. Kendra was the only participant who did not openly discuss this action; however, her mentee, Angie, suggested reflection in the form of statements such as, "How did it go?" or by Kendra reminding

Angie to “always look back and see what you’ve done before that has worked well. Start there and grow from that”. Amy and Lori discussed reflective practices with their mentees when reviewing lessons. While Carol shared using the phrase, “what can we do to make it better”, Cora signified her reflective practice was more in tune with her mentor’s perceptions when she stated, “I’ll have thought, I wonder what Carol would say or I wonder what Carol would do.” Cora felt this was a form of reflection since she was “keeping in mind her (mentor’s) way of doing it”.

The mentoring dyad of Mary and Karen also utilized reflective practice as a form of support. Mary’s descriptions not only pertained to her mentee, Karen, but to many other individuals she has worked with when she stated, “I get people calling me all the time and say I was doing this lab and this happened and why did this happen. So then we have to figure out why. It might have been something they did not do right while they were doing the experiment.” When Mary shared her conversations with Karen that employed reflection, the focus was not only on the action of the teacher but about student learning. She recounted, “We discuss how things went or what happened when students did this or that. We do a lot of that when we talk back and forth. It helps both of us.” Karen corroborated this perception and shared an anecdote about working with primary children’s responses in which through reflection and suggestion, she was able to promote “process skills such as observing” within the students.

The three themes that emerged from data pertaining to the role of the mentor were emotional support, technical support, and educative support. There was not one particular role that each mentor took on since all mentors suggested various aspects pertaining to their practices.

These roles were underscored by two other patterns or overarching themes. The first of these themes was each mentor's commitment to the mentoring process while the second overarching theme addressed each mentor's interchangeable role depending on the context of the mentorship.

Commitment to Mentoring

Mentoring for each individual was featured as a very positive experience. With the exception of Lori's experiences at the magnet school, each mentor was actively sought by the novice for mentorship. These relationships were not assigned or suggested by administrators but reflected the mentee's desire to become more proficient in elementary science and the mentor's assistance with that desire.

The amount of time spent on the mentoring process differed by dyad and individual mentor. These differences were attributed to location and professional responsibilities. For the dyad of Mary and Karen, each teacher retained positions at two different elementary schools approximately 20 minutes apart. This distance caused a heavy reliance on emails and phone calls or after school meetings. While the other participants of the study were able to mentor within their own school, the dyads were not working within the same grade levels nor was there allotted planning time for specific mentoring. As a result, the greatest amount of face to face mentoring occurred after the school day ended. The one exception was Lori whose position encouraged a mentoring relationship with the teachers within the magnet school during the school day. She was able to work alongside her teachers, observe their practices, and frequently model lessons.

This assigned position was not the norm for the other individuals nor was it reflective of Lori's current mentoring relationship with a fourth grade teacher.

The commitment of time outside the school day appeared to be an issue for several of the mentors. Carol spoke of the difficulty of finding time to meet with her mentee, she relayed, "At first, we spent a lot of late afternoons together in order to do the things we needed to do." Another mentor, Abbey, admitted, "One of the things that is hard about being a mentor is time. I mean it would be wonderful for me to sit through a forty minute block and watch them (her mentees). Or be able to co-teach with them when they get a really good idea or something." Along with this sentiment was Mary's description of her frustrations, "The time commitment. It always seems like when I am the busiest. I just don't have enough time. I end up spending my personal time outside of the day and on weekends. It's the time in juggling my needs over their needs. I feel like I have a good heart and I don't want to let anyone down. So, sometimes I put down what I'm doing because they're desperate and full of tears and need something. I end up being stressed out and I need to find a happy medium with that. That is something I need to work on." Despite these descriptions, each mentor posited mentoring was fulfilling and a means towards improving science education within the classroom.

A commitment to mentoring not only involved the mentor's time but their energy and resources. Within each voluntary relationship, the mentor would problem solve, model, discuss, or conduct physical activities such as helping arrange desks or compiling materials for the mentee. These actions were completed because the individual mentor felt she had something important to share with the mentee. However, these actions were not always well received.

Each mentor depicted negative mentoring experiences pertaining to some aspect of the mentoring process. Carol relayed an incident with a mentee that happened several years previous to her relationship with Cora, "She (mentee) did not receive my feedback. It was in one ear and out the other." Mary also recounted something similar, "I am thinking of this one gentleman who was not even pretending to listen to what I had to say. And then, when I was giving suggestions, he was outright belligerent about it and not polite. So, I held back a lot." Notwithstanding, the negative examples were not enough to deter each mentor from participating in other mentoring relationships. Lori's comment typified all the mentor's feelings when she said, "And then, there are teachers, I have to be truthful, who just don't want to change. And that's hard. That was discouraging. You always have one or two, but then you have everyone else who is very eager to learn. They want their children to be successful." The mentors agreed that student learning within elementary science was a noble motivation for continuing mentorship.

The overarching theme of commitment to mentoring was accompanied with a second but equally important notion related to the role of the mentor. Perceptions revealed mentoring was a fluid activity not confined to one set role. Patterns of behavior noted within data were aggregated into three types of mentoring roles or themes: providing emotional support, technical support, and educative support. However, the role each mentor enacted within a relationship appeared dependent on the context of the relationship.

Flexible Mentoring Roles

The five mentors within this study were not only committed to their roles but relied on various forms of mentoring. Within the three types of mentoring roles, emotional support, technical support and educative support, each individual reflected different degrees of combined patterns as well as changing that pattern depending on the nature of the mentoring relationship.

Lori and Amy were the two mentors who did not have mentees participate within the study, and as a result the roles only reflect the individual's perceptions. Of the five mentors, Lori's role seemed to change the least. She ascribed herself as a caregiver and desired to improve teacher efficacy through her mentoring role. Nevertheless, most of her comments concerned technical support in the form of coaching or modeling. This changed very little whether she was referring to her position as science resource teacher at the magnet school or in the current mentoring relationship with a fourth grade teacher. The greatest difference was the voluntary nature of her current role in which she did not provide emotional support but was more focused on technical support. She stated the fourth grade teacher was "very good, very creative" and her greatest effort in working with this individual had been "helping with materials and that kind of thing".

Abbey, on the other hand, tended to provide more emotional support to her mentees than technical or educative. The majority of her comments focused on building a relationship through positive support. Her two mentees were experienced teachers, who she described as "strong teachers who wanted to feel more comfortable teaching hands- on science". Because of this lack of ease, she felt her statements of encouragement and time spent with them helped to build the mentoring relationship. Yet, Abbey also described another mentoring scenario with a younger teacher who was struggling with classroom management and pedagogical issues. In this context, Abbey's depiction of a mentor who was emotional supportive changed to a mentor more focused on dictating a certain way of doing things. She relayed, "She (a younger teacher she had mentored) had an evaluation. It didn't go well. She was told to improve before she was re-evaluated. So I told her, 'What the principal wants to see is the standards. You can do whole group reading but put your centers up and pull small groups. That way, he can see how you are individualizing. You were trying to do five different things in forty minutes….I am not here to steer you wrong. I know you are a young teacher. I know you are excited about what you do but I am here to help you. Take it with what you will.' She didn't take it and there were concerns with problems with parents." Abbey's manner of mentoring was not encouraging but appeared more didactic when interacting with a younger, inexperienced teacher.

Carol's mentoring role blended emotional, technical and educative support with the greatest amount of comments pertaining to educative support. Her description of mentoring consistently ascribed the mentee as a learner and as a result her role would change dependent on what the learner needed. Since her mentee, Cora, needed the greatest assistance with science projects and science fair guidelines, Carol spent an inordinate amount of time providing resources, modeling set ups, and discussing judging criteria. As for classroom practices, Carol suggested her mentee did not need a lot of assistance because "she had a real knack for doing that. She was a veteran teacher when she came here and didn't need help except with science." This was not true of another mentoring experience that Carol relayed in which the mentee struggled when developing positive student rapport. In this relationship, Carol said she attempted to work with the novice through suggestions and role modeling a positive, caring attitude, but did not find the mentee receptive.

Kendra and Mary's mentoring roles were quite similar when working with small groups but changed in the context of one-on-one mentoring with a novice. Both mentors depicted strong technical mentoring when working with small groups of teachers or even with certain individuals. However, it was the comments of their mentees that suggested a change in role due to the intimacy of the relationship. Kendra offered very few comments pertaining to emotional support except when attempting to make teachers feel comfortable in teaching science. Yet, her mentee, Angie, adamantly described a close friendship with Kendra that was "deeper" than mere collegial interactions in which both individuals understood "what their passions were". She relayed frequent contact with Kendra that was positive and uplifting thus encouraging her as a teacher. These descriptions were not included within Kendra's conversations about mentoring since most of her perceptions related to a variety of individuals she had assisted.

Mary also demonstrated a difference in roles when examining her relationship to Karen, her mentee. With the individuals who came to her classroom for assistance with setting up a science lab, Mary's perceptions were for the most part technical combined with an open-minded attitude toward each mentee's reaction to her suggestions. It was Karen who offered another perspective about Mary's mentoring that included sharing a vision of teaching, collaborative planning, and the building of a strong friendship which Karen stated was "almost like having a boyfriend". Although Mary did describe some of these actions, her mentee presented a more coherent picture. Within this intimate relationship, Mary was more likely to demonstrate educative mentoring support.

Determining the role of each mentor was one guiding question for the study and revealed three themes of emotional support, technical support, and educative support. Two overarching themes also emerged pertaining to commitment of the mentor and flexibility within the roles the mentors enacted. These themes were within the context of teaching elementary science and underscored those aspects of the five factor mentor model ascribed by Hudson (2004). Findings pertaining to the second and third guiding questions which refer to this model will be addressed in the next segment of the chapter.

Five Factor Mentoring Model

In this section, the mentors and mentees described the mentoring experience within the five factor model delineated by Hudson (2004).   The five factors for effective mentoring in elementary science included personal attributes, system requirements, pedagogical knowledge, modeling and feedback. This section was organized around those factors through the examination and analysis of observations, field notes and all participants' responses to select questions about each facet of the model. Each section contained the mentors' perceptions and mentees' comments which either corroborated or differed from the mentor's descriptions. Figure 2 offers a context chart of each factor with corresponding themes. The researcher chose to illustrate these concepts using a nondirectional cycle diagram because each shape has the same level of importance. This was the case with the five factor model since each factor was equally important in promoting effective mentorship. Directional arrows were not included when connecting the factors because the relationship amongst factors was not always within a prescribed sequence. The personal attribute of support via willingness to model also encompassed the factor of modeling in which the mentor demonstrated teaching practices to the protégé. This in turn revealed the mentor's repertoire of pedagogical knowledge within elementary science. As a result, the factors were equally related to each other depending on context.

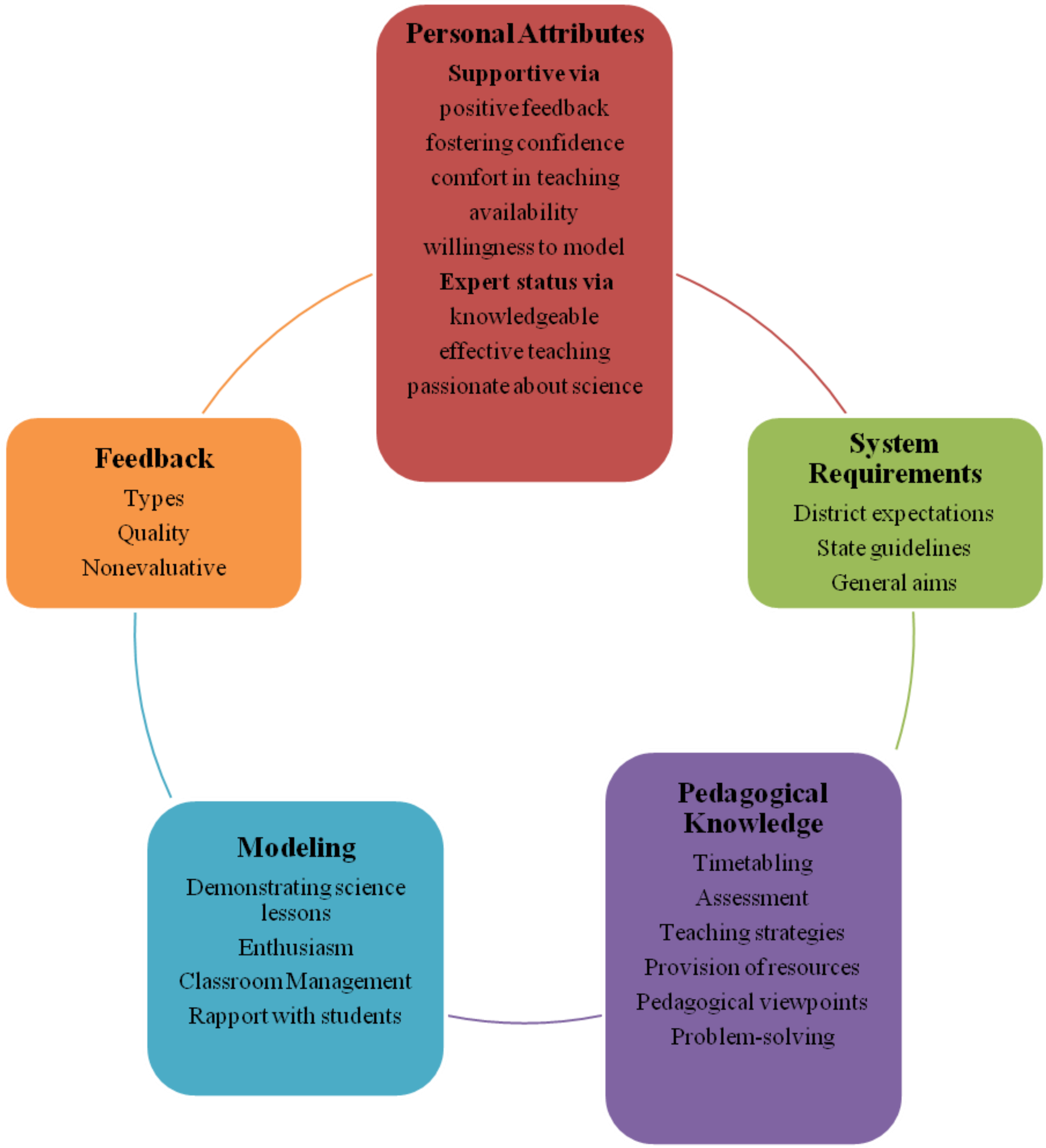

Figure 2: Factors for Mentoring in Elementary Science

Personal Attributes

Data for the mentoring model factor of personal attributes were collected utilizing ten questions (see Appendix B-1, B-2). These findings mirrored those qualities found within the mentoring roles and emerged as two themes with subsequent categories. The personal attributes theme of supportive included the categories of positive feedback, fostering confidence and comfort when teaching science, availability, and willingness to model. The second theme centered on expert status and involved knowledge, effective teaching, and passion via enthusiasm and fun activities.

Support for teaching science was a recurring statement within all participants' observations. This personal trait on the part of the mentor was viewed as critical in assisting the mentee with the teaching of science. Positively supporting the novice was noted through a mentor's willingness to model appropriate elementary science pedagogy or through positive feedback pertaining to a novice's actions or thoughts. One mentor, Mary, stated, "I think after they see me model it (the science lesson) they get some ideas on how to handle it. I think that's the biggest scare, besides the content. Content can be fixed easily. Just go and look up something… And the fact that it's okay that we are not supposed to know everything. It's okay if you don't know everything in science, and you don't have to pretend to know everything. Science is a huge, huge thing. Even scientists do not know everything." Mary emphasized a practical approach to gaining expertise within the field and her acknowledgement of inadequacy was countered with a "teachable willingness" to research what was not clearly understood. Each novice also suggested the practical component of showing how to do science as one means of demonstrating positive support. Karen, Mary's mentee, summed it up when she relayed, "Mary demonstrated support for me by sharing how to do labs and other hands-on activities. Also, how to integrate it (science) with other subjects. This is a biggy, because a lot of teachers think you have to set science time aside and teach just science."

While each individual described some aspect similar to the previous anecdotes, they also suggested positive feedback as a means of encouraging and supporting the novice. This feedback came in the form of emails, notes, or face to face discussions. Abbey encapsulated this idea when she shared, "I try to instill a positive attitude by instilling confidence through encouraging them (her mentees) to ask questions and how to find things….but I am also a listener of what they are nervous about or what they enjoy and then guiding them on how to capitalize it." For the mentees, this feedback was described as "always positive", making the job of teaching science "a lot less daunting", and helped with building "confidence".

The notion of support through fostering confidence was echoed in other participant comments and emerged as another theme within the factor of personal attributes. In the same manner as the promotion of positive attitudes, the mentors perceived building a novice's confidence through the provision of resources or positive affirmations and also by role modeling a positive demeanor. Each mentor posited providing the novice lesson plans or resource materials underscored their confidence.   Kendra summed it up in this way, "Hopefully, by getting all the professional development they (mentees) could want and the materials to do it with. They don't have to come up with ideas themselves. There are plenty of books. They don't have to reinvent the wheel." Her mentee, Angie, concurred with this demonstration of support when she described being "taken hands-on" through the schools resources and then being able to utilize these materials within her daily lessons.

Role modeling was another venue the mentors used to instill confidence in their mentees. Lori stipulated, "Well, by being positive myself. Letting them (mentees) see that when I modeled. I had to do that once a week. I did it often especially in grades 3 to 6^{th}." Carol's comment was quite similar when she said, "By modeling a positive attitude, I guess. By modeling a love for the subject. If you're enthusiastic yourself, then it tends to rub off….And the confidence to feel good about the things that she (her mentee) is doing because she does do an awesome job in the classroom." Abbey also suggested the idea of modeling as a means of instilling confidence; however, she presented the notion in this way, "So, through me, the mentorship came through modeling the scientific method. Where it starts with hypothesis, research, and going from there, how to teach that to the kids. By this they can feel more confident."

The mentee participants within the study offered another perception of a personal attribute that was suggested by the mentors but appeared to be very important to the novices. Each mentee ascribed availability as a key factor in supporting their practices. Cora suggested, "Through her availability, I feel like I am never in it alone." While Karen described the importance of accessibility in building a relationship that was "really close" and which allowed her to be "comfortable in talking to her (mentor) about what worked and what didn't work". Angie described her perception in this manner, "We meet together once a week to make sure each other are strong and how we need to be supportive of each other. And so by doing that, it opens up the doors to what we need to be doing and how we need to go about it. If something is wrong or if something is bothering us, we can always go to the other one and say this is what's happening. We have that shoulder to be there, that support for that."

The theme of support as a personal mentor attribute was noted within the role of a mentor as was the emergent theme of a mentor's expert status. The expert status of a mentor was a personal attribute that included three categories: knowledgeable, effective teaching, and passion for teaching. The expectation for a mentor to be knowledgeable about science was an important characteristic discussed by each teacher. Kendra, stated, "To be a mentor, you have to be real sure and real knowledgeable. You really have to be an expert in what you're doing in order to teach somebody else." A different mentor, Abbey, stated, "Mentoring another teacher is almost like teaching kids. They don't have the framework to build on. So, I am always telling them you need to read this and go to this website. I have just spent so much of my time learning science these last years that I kind of expect them to do it. Not everybody is willing to do that." This mentor underscored the notion of teaching as a learning process when she mentioned her "learning science" over a period of time. Her expertise allowed a sharing of resources with mentees.

Mentee comments also portrayed the importance of the mentor's expert status. Cora admired her mentor for "her confidence, her knowledge of vocabulary, and her willingness to share what she knows and how she knows it." While Angie shared her mentor's ability to bring content "down a level" enabled her "to explain it (the science concepts) to the lower levels".

Knowledge about elementary science pedagogy was a critical element within the mentoring relationships since the mentees would not have otherwise sought out their individual mentors. As Cora stipulated, “She (her mentor) is the one I go to when I have questions about science.” For the mentors, being knowledgeable about science was a trait they demonstrated to their mentees in a variety of ways.

Another aspect of the mentor’s expert status was as an effective science teacher. The novices’ descriptions of effectiveness were somewhat more limiting than the mentors. The mentees told about their mentors’ abilities to engage students in learning, to conduct hands-on activities efficiently, to “focus precisely on the benchmarks”, and create “unique, interesting” lessons. The mentors spoke of these actions but were more likely to include effectiveness in terms of what and how much students learned. Abbey considered her “effects” upon students in this way, “I have a passion for teaching. I can get the kids excited about it. There have been some drawbacks like last year’s scores. You know when you look at your FCAT, there are five different sections. There were two or three that went down. I was looking at those. I started to take it personally because this is why I am in this position. It’s to make these five sections go up and these three went down.” Another mentor, Lori, felt her mentoring had positive effects when she shared, “We saw tremendous gains for those years (of mentoring) in FCAT science by doing one-on-one and creating the materials that they (teachers) needed.” Whether the scores were high or low, each mentor spoke of state assessments such as the FCAT or district assessments for measuring student learning as key determinants of their effectiveness. Each mentor suggested her actions with students as well as with mentees contributed to student learning. Kendra espoused this viewpoint when she noted, “our scores were actually good this year. We beat the district and we beat the state, but it’s where we were two years ago. We had dropped sixteen points and came back up. It’s a roller coaster. Our population has trouble because they can’t do the higher thinking yet, because it (FCAT) is not concrete enough…I try to do higher questioning in my room and model it to the teachers. But it has to be carried over from kindergarten on up through the grades by the teachers also. I hope that when the teachers see me doing it, they will follow through in their classrooms. This would really help the kids!”

The third aspect pertaining to expert status was a passion for teaching science demonstrated through the teacher’s enthusiasm and ability to make learning fun. Abbey, a mentor stated, “Enthusiasm for science really makes me a better teacher. My philosophy is if it’s not fun, don’t do it. You can make anything fun, if you put your mind to it.” Another mentor, Lori, stated, “I get excited with the children about what they find. When the children get excited about science, you know that you are doing your job well. It goes beyond learning the basics and that is important.” Kendra also included notions of passion for teaching science as a part of her comments. Not only did she include making science fun for students but also an enjoyable personal activity when she shared, “Yes, I show a lot of enthusiasm because I have a lot of fun teaching science. It is my happy place.”

Mary’s descriptions of enthusiasm and passion for science teaching echoed the notion of fun when she relayed, “I try to be as fun as I can be. I am more of a serious person, but I do joke around a lot with the kids. I try to be goofy because children like it when you’re goofy. I know that my whole objective is for them to have a passion about science. Usually they hate science.

Even at my school, a school for science, they hate science. I win them over and they love science because we are always doing fun things. It's not just reading out of books which is what they have been used to, unfortunately."

The personal attributes described within data presented by the participants materialized into two large themes of support and expert status. Within those themes, the mentors were perceived as supportive through modeling appropriate pedagogy, positive feedback, instilling confidence, and availability while the second emergent theme of a mentor's expert status involved knowledge, effective teaching and a passion for teaching science. The notion of expertise within science was interrelated with knowledge about requirements for teaching science which was noted within the next factor of system requirements.

System Requirements

System requirements were those goals and standards that provided "uniformity and direction" in teaching elementary science (Hudson, 2004, p. 142). They included knowledge of Florida's Sunshine State Standards, state and district mandates, safety policies, as well as global aims for developing a scientifically literate population. Four questions pertaining to the factor of system requirements were directed to each participant (see Appendix B-1 and B-2). Three categories were indicated within the conversations with mentors and mentees: the district's pacing guide, state standards and guidelines, and general aims for teaching science.

Brevard County has created a district pacing guide specific to elementary science. Within the guide there are sections pertaining to Florida's standards for teaching, safety and science fair guidelines, and a pacing plan for timetabling instruction throughout the year. Each mentor shared "going over the pacing guide" with their mentees, and as science Point of Contact (POC) for their school, they discussed reviewing the document with their faculties. As Kendra stated, "Part of my job is to have one person from each grade level meet with me once a month. We go over whatever I get from the district. When we first got the new assessments, we went over the pacing guide and stuff." Her mentee, Angie, corroborated this when sharing, "We have also looked at all the district level material, making sure everybody is where they are supposed to be and that our scores are raising on how they need to raise." Through discussions of these essentials, the mentors suggested that mentees would begin to comprehend how system requirements were practiced within a school and classroom setting.

Florida's Sunshine State Standards was a topic every participant mentioned quite frequently in relation to system requirements. The discussion about standards took place either collectively within teams, faculty meetings, or one-on-one within the mentoring relationship. Describing the first scenario, Kendra stated, "We actually have a monthly team meeting with our entire science contact team where there is one teacher from every grade level that comes in. Starting with week one at the start of school, we went through each area that we were supposed to be looking at. We wanted to make sure we were covering all the standards we needed to cover. And that we truly understood the standards and all the terminology that is mixed up in them." Carol portrayed a similar mentoring experience with her faculty, "We shared some performance task questions amongst each other and tried them out with the kids. We were making sure they have a hypothesis and do they understand what a variable is…. We also do a lot of what does second grade want from first grade teaching in science by looking at the standards." It was in this context that their mentees, Angie and Cora, shared about receiving guidance pertaining to the standards.

The second scenario of discussing the Sunshine State Standards with the individual mentee was reflected in Mary's statement, "I discuss the standards every time, just about. For instance, she (her mentee, Karen) and I meet on a regular basis to do our lessons. We do our lessons together for what she does in her lab and what I do in my lab. Now, she is at a Title One school and I'm not. So, we kind of know that she may do it one way and I may do it another way. But we discuss it, and we bang ideas around and talk about it. We have those standards out all the time because we have to use those state standards to teach." Karen concurred with this statement when she relayed, "We have gone over them (the standards) extensively. I figure one more year and I will be able to quote them verbatim." Lori relayed sharing the following statement with her mentee when instructing her on the state standards, "Our state is very fortunate because we have a very specific group of standards and expectations. And if we follow those and use those as our aims and our goals, we are pretty safe. It's not ambiguous for us. We know where we need to go and what we need to do." She elaborated this discussion by pinpointing specific standards for the grade level her mentee taught and why "we push the students to their goals so that we can build on that".

The third topic indicated within the findings was discussed in terms of general aims for teaching elementary science. This particular question appeared to be misunderstood by each participant since the aims of science teaching related to the development of a scientifically literate population. The notion of scientific literacy illustrated concepts from science reform efforts related to students' understanding and evaluation of scientific concepts (Duschl, 2008) Because this was unclear to the individuals, the following statements represented "muddy" responses to the question. As one mentee, Angie, stated, "Well, science is a special category. Everyone knows why science is important. If we didn't have science, we would not be where we are today." Abbey, a mentor suggested, "Yes, the aims are broad, but obviously they are what Brevard County sets up for us with the 'Big Ideas'. These are aspects we have to touch. This is where the kids need to be confident." When considering the question, Carol stated, "We (my mentee and I) have discussed things about science fair and the scientific method. The goal is to get the kids to think how and why. To come up with a question and then the answer." Mary appeared somewhat disturbed when asked if she discussed the aims of science with her mentee. Her interpretation of the question led her to focus on why science is taught. She stated, "I don't think I have ever had to tell mentees why we teach science but I've had to tell students. I tell the students that science is everything. Everything around you involves science. So that in order to find out how something works, it will involve science."

The factor of system requirements revealed three themes of district guidelines, state standards, and the aims of science. Whether mentor or novice, each individual emphasized the importance of basing science lessons on the district and state requirements since these served as "beacons of appropriate science instruction". A mentor's expertise about system requirements was also interrelated with her pedagogical knowledge in which she could relay "what she knew and how she knew it".

Pedagogical Knowledge

Within the five factor mentoring model (Hudson, 2004); pedagogical knowledge incorporated the many aspects of teaching a subject which are critical to a successful learning environment. The participants were asked eleven questions (see Appendix B-1, B-2) related to pedagogical knowledge; responses revealed the following themes: providing resources, timetabling, assessment, teaching strategies including classroom management techniques, problem solving, and pedagogical viewpoints.

The first category was an amalgamation of statements from mentors and mentees alike describing the mentor providing resources of some kind to the novice. Quite frequently, the mentors gave lesson plans to the mentees. For example, Kendra noted of the many teachers she has assisted, "Sometimes there will be a teacher who says, 'Okay, at third grade we are getting ready to do energy. What kind of lesson would you want us to do?' I would put together a cart for them with all the energy stuff on it, but I would also give them the lesson. Or I would actually show them the lesson and say this is how I would do it and use it. They are not really developing their own lessons. I am kind of giving them my lesson plans." A similar statement was echoed by Abbey when she said, "My lesson plans are in a folder on my computer. This is like an open book for them (her mentees)."

Lori's ideas of providing resources were illustrated in this statement, "I would also do workshops or mentoring times with them. One-on-one times with them in which we would talk about the skills, the information they would need to know, where to go to find that information like the internet or materials and books." She further commented, "We would purchase materials like demonstration tables. They had everything they needed for a good science lesson." This type of assistance was also reverberated in many of the statements of the mentees. Karen relayed, "We went to workshops together. We went to one about science misconceptions and talked a lot about questioning to identify and correct misconceptions." Angie suggested assistance was a more hands-on approach with her mentor when she said, "Like I said, we (she and her mentor) hatched eggs this year. For the second year in a row, we have looked at the space program together. We have gone up and down Lagoon Quest looking over all the different areas and aspects together to make sure everything fell in line and it was a wonderful connection."

Timetabling which included planning for weekly lessons and the pacing for the entire school year was another category the participants discussed. For the mentors, the emphasis tended to be on assisting the mentees with adequately planning mandated science curriculum with its corresponding district and state assessments within a year's time span. Abbey stated, "Another thing is to show them they have to think of their curriculum in a year's plan. They can't go, okay, what am I doing this week?" She continued to elaborate how she aided her mentees by saying, "One of the things that I developed was like a spreadsheet that would have each week of the school year. And this week I would be concentrating on this strand. And then, I plug in the strands, or, in this case, the Big Ideas. That way I would know that on this week, I was teaching this Big Idea."

Mary discussed timetabling in terms of both yearly goals as well as weekly plans depending on which mentee she was referring to. "Today, I met with a gentleman for the first time. We were looking at the main topics we were going to be teaching. I just roughly and briefly stated that he could probably teach this in four weeks and teach this in three weeks. We will now need to go back and look at specifics. I told him he needs to think specifically about what he needs to teach. That way, we can give it a better time line." However, with her other mentee, Karen, she advised, "The biggest thing is that you need to be prepared. I told Karen do not leave you lab on Friday until you are set up for the following week. This is because she goes in on the weekends and spends the whole time trying to get the labs ready. That's something!"

The mentees also considered timetabling an important issue for effective teaching. Angie stated, "The biggest issue she (her mentor) and I have discussed is time. It is time consuming to get the materials together." Karen stated, "One thing she (her mentor) taught me was to send the teachers the whole month's labs in advance. So they know what you are doing on what day….She also helped me with the timeframe. She has her kids trained to come in and sit down and copy the problem and hypothesis. She doesn't even tell them to do that. Where I wasn't at that point yet. And I am still not at that point. She would help me with that timeframe of the forty minute block of time. I am not there yet, but I'll get there."

Assessment was another theme within the factor of pedagogical knowledge discussed by teachers. Mentors and mentees discussed different types of possible assessments that can be used within elementary science. These statements about assessments ranged from references about Florida's science FCAT to informal assessments such as observations. Abbey, Kendra, and Lori's comments were focused largely on the annual FCAT assessment for science. They shared their school's scores as effects of their teaching and mentoring. While Carol's statements about assessment were mostly concerned with what she had specifically discussed with her mentee. She recounted, "I have modeled how to do response logs but most of hers (her mentee, Cora) is done through observation because they are so young. They don't do a lot of writing, but they do a lot of graphing." Mary shared from this perspective as well when she said, "Most of the people I have mentored are science lab teachers or teachers that wanted help with hands-on learning. Mainly, just doing quick visual assessments and doing a lot of conferencing. I use probes by Page Keely on accessing students' ideas. There are four books that are basically like a pretest kind of thing. It's probing their minds about something before I do the instruction."

The mentees discussions also echoed this range of assessments. Angie posited, "Here at our school, we use our district assessments. There is always a teacher prerogative on how a student is doing and we tend to use that also. But when it comes to the actual assessment of the student, we use the district assessment. Kendra (her mentor) has gone over the results with us. There may be an instant gain or decline in the student's knowledge when you look at the test. It's actually very helpful to see, because if you have quite a few students missing something, you know you did not cover it correctly." The district assessments were required by Brevard County for each grade level. These assessments reflected three areas of science, life, physical, and earth/space as well as including pre and post tests. Although every grade level was required to assess students within science, Cora, the first grade teacher, did not admit to any discussions pertaining to assessment with her mentor, Carol. She explained that the nature of their relationship mostly pertained to science fair or “general science kind of things”.

Karen, the science lab instructor, discussed other forms of assessment she had gleaned from her mentor, Mary. Karen emphasized learning about response journals and their importance within the primary grades as a means toward ascertaining what students understood. She relayed, “We had them drawing shrimp with the rostrum and the carapace. I would draw the shrimp in front of them and then I would have it up on the Smart Board for them to label the parts. Some of the details on their drawings were amazing.” Karen further explicated, “In fourth, fifth and sixth grade I would have a probe displayed on the Smart Board. They would have to sit down and I would give them about three to four minutes to discuss. And then, I could use it as an evaluative tool to figure out where they were, how much they knew, and figure out if there were any misconceptions.” Previous to this conversation, Karen admitted to sharing numerous discussions with her mentor about ways to elicit students’ science ideas. From these discussions, she had implemented several ideas that she found successful within her classroom.

Another component of pedagogical knowledge that was revealed within data was varied teaching strategies suggested by the mentors to their mentees. One example of this was Cora who shared how her mentor assisted with guided discovery and “the fish bowl way of doing an activity”. She explained, “It’s like I am here in a fish bowl and my students are watching all circled around me but at a distance.” Cora considered this an effective technique for science instruction and for other subjects as well. Karen relayed her mentor’s suggestions about using science journals within the science lab as well as effective questioning techniques. She stated, “We talked about using higher level thinking questions especially Webb’s depth of knowledge. The science FCAT, the new one, and maybe even the old one, I am not sure, does not use Bloom’s taxonomy. It uses Webb’s depth of knowledge. The new science standards use the same thing. Webb has four levels whereas Bloom’s has five. So, that’s something interesting.” Karen added the importance of learning new techniques helped her to improve instruction and “become a better teacher”.

Mentors noted other teaching strategies in their discussions with their mentees. Carol stated, “A little bit of the presentation method, how to set it up for what you need, and definitely vocabulary. I tell her don’t be afraid to use big words just because they are first graders”. Kendra’s conversations reflected her concern about mentees using traditional forms of instruction when she said, “Sometimes, it may be a teacher demonstration is going to be best. I don’t like for them to depend on just a teacher demonstration. No, that is not enough. We bought wonderful teacher demonstration tables for those kinds of things we do not want to have students do because they may harm themselves. So, sometimes that is best.”

Cooperative learning within the science classroom was discussed by all five mentors as a teaching strategy that enabled effective classroom management. Mary stated, “I shared with them (all her mentees) my cooperative learning model that I use. Which everyone pretty much knows the cooperative learning model. How I set it up… I have it posted but I do email them how I set up the ‘getter’ station where they (the students) go and get the materials.” Lori’s use of cooperative learning was quite similar when she shared, “I showed them (the mentees) how to group students, how to call on students, how to get them into the groups. As you can see, my groups consist of 3D. I showed them how to build responsibility by having students get up to get materials, by having students become responsible for data recording, sharing and other areas of discipline with the teachers. I worked with them in groups by having three or four groups." Even the mentees acknowledged the mentors' emphasis on cooperative learning. Angie relayed, "Cooperative learning is very big at our school. With cooperative learning, we all work together so much better because the kids all know exactly what is expected of them. Every grade works with her (mentor). She gets down with the kids. She is not afraid to go out and dig a hole with them to show what erosion is like."

Combined with the notion of cooperative learning as a classroom management technique, the mentors also shared management techniques that physically assisted the mentee. "There have been times," Abbey stated, "when I went to their classrooms and helped them arrange the desks in a certain way to help with the flow of traffic. Or showed them how to set up the trays for science, almost like a food tray that was pre-packed." Karen shared of her mentor, "With Mary, she helped me to set up my lab with a prep closet that has floor to ceiling drawers for each grade level…. The tubs hold all of my materials for labs. That was a big help."

Another category indicated within the findings for pedagogical knowledge was problem solving. The mentors' suggestions for helping their mentees solve problems included reflecting via discussions, researching new strategies, or providing suggestions for possible solutions. Abbey and Lori spoke of reflecting on what went well and what did not as a means of leading a mentee towards resolving a problem. Lori continued to elaborate on this point, "If they are having some success, my suggestion is to maybe modify because every teacher is different. I don’t expect my mentee to come in and do it the way I do because it feels comfortable to me. It’s like taking someone’s plan or like the discipline plan. I take the discipline plan, I use it and base what I do on that but I modify it so that I feel comfortable with it. Not every teacher is going to do it the same way. So, what we have to do is find out what happened and reflect on that. Then we say, how we can change it, so that you are comfortable with this. Maybe, this particular hands-on activity is not the one you should use. Let’s look and see what else is out there to find one you are more comfortable with.”

Mary’s notions were in a similar vein when she stated, “I get people calling me all the time and say, ‘I was doing this lab and this happened. So, why did this happen?’ So then, we have to figure out why. It might have been something they did not do right while they were doing the experiment. Basically, many times through discussion we talk out the problem.” Karen, her mentee, reiterated Mary’s comments, “She tells me to go with the flow and think it through. If the experiment doesn’t work, you need to say maybe we didn’t control our variables or maybe we didn’t do something properly.” The notion of reflection as a means towards solving problems was also shared by the other two mentees, Cora and Angie. They described mentor behaviors in which each mentor took time to discuss issues and asked the individual to examine “what has worked”.

Pedagogical viewpoints, in particular the use of inquiry within the elementary science classroom, were another venue for discussion amongst the mentors and mentees. Kendra stated, “I am very hands-on. I love inquiry but teachers aren’t comfortable with that. So, I suggest they do multimedia then. If you can’t do the hands-on, then just get them out of the textbook. I just want the kids out of the textbook by giving them another means." Her mentee, Angie, reiterated this sentiment, "We use the inquiry theory here. Either through robotics or the science we teach. We use inquiry because it allows kids to dig deeper for the answers they already know and to pull it out, if it is hidden. By using that, it helps the kids to feel better when they discover the answer." Lori completely agreed with this notion when she shared, "It is important to not be text bound driven. You do not start at the first page and end at the last page…..You look at what needs to be taught. You don't want to throw those tests (district mandated assessments) at them. I want the students to be successful." Lori continued to elaborate the difficulty some of her mentees have had with this pedagogical viewpoint. "It is easy for me because I have done it. But for some, you know, they want everything organized. One example was when we were doing our balloon cars. We had races down here and had to move tables. Or when we did Lego cars, we had to move everything out. Some teachers had a hard time with that because they want it organized. But it is very important for me that they (the students) are learning from the experience."

Not all participants felt strongly in favor of utilizing inquiry within the classroom. Karen, a mentee, shared, "We (she and her mentor) talked about inquiry. The whole inquiry thing I thought was kind of overblown at the beginning because some people were real big on full inquiry. And with some children, like the kids at (Mary's school), you could do full inquiry. They have the background to make the connections. But if you take the kids at my school and give them a bunch of stuff and let them do a full inquiry, they are going to be playing around without the background knowledge. I don't think they will make those connections. I think it's something you can build. I hope to build it over time in the lab. Mary and I talked about that a lot. She gets to do more full inquiry." The relationship between Karen and Mary afforded open communication in which differences of opinion were respectfully considered.

Modeling

Modeling was another factor within the five factor mentoring model developed by Hudson (2004).   Although only six questions pertained to this factor, it was clearly evident throughout the interviews with each participant that mentors modeled enthusiasm, strong rapport with students, as well as demonstrating science lessons and effective classroom management.

In exhibiting enthusiasm, the mentors provided consistent depictions of animated science classrooms. Carol shared, "They (the students) think I'm the crazy science teacher. You know we do the Mentos in the soda and other fun stuff. Sometimes we do things just for fun versus having to do a lab and write about it. Of course, they're learning things as we go along." Cora's perception of Carol's rapport with the children corroborated this view when she said, "I find her to be enthusiastic. Her enthusiasm is not a demonstrative, high pitched, 'Mr. Science Guy', but I found her enthusiasm to be really good with the science discovery approach."

An enthusiasm for teaching science was voiced in Kendra's responses, "The kids know I get kind of excited. So, it's a very active and noisy classroom. Actually, they keep trying to find me a room that won't disturb another classroom. I found out the loudness goes through the ceiling and the brick walls." She continued to elaborate, "Sometimes, I get too enthusiastic. I've told the kids too, that when I start talking science sometimes I get saliva and start dripping. They know to stay back a little when Mrs. N starts getting crazy. I run around and put wigs on and be silly. Anything goes!" This outlook was repeated in her mentee's description of Kendra's classroom, "Absolutely! She is very enthusiastic whether it is dressing up in wigs or going crazy for the kids. She is always very enthusiastic. Because of that, they love being here and that is a huge deal, especially in our environment and our area. Making the kids passionate about something that opens their doors for later is always an exciting adventure."

Combined with a demonstration of enthusiasm, mentors and mentees noted teacher/student rapport within their comments. The mentees noted this rapport with remarks such as, "She challenges them (students). What she does is challenging but fun. Focused very precisely on the benchmarks." In describing her mentor, Angie remembered, "With the fourth grade, this year, they love science. It is a passion. They love to be here and interact with her. She makes it so fun for them. It is a treat for them to come in here doing science experiments, having fun times. It is almost their stress relief to come to science." Karen shared this perspective, "It depends on the grade level. She (her mentor) can be really silly with the younger grades. And it also depends on what she is doing. Like when she did an unauthorized experiment, she was all business."

Some mentors attributed a structured atmosphere contributed to a positive rapport with students. "I am very structured but when the children get excited about something I want them to share," Lori disclosed. "They are not afraid to share because they know it is okay. I do want them to get excited about what it is they are doing." Abbey also concurred with this viewpoint when she noted, "My students know who the boss in the room is. But they also know that I'll sing, I'll dance. For gravity, I'll let them jump off their chairs. There is an element to it. For someone who cannot think outside of the box would have a lot of trouble with science. I don't want to say play with them but they (students) know there is a structure and order in the room. One word, one look, and their back to normal. That's how you have to make science fun." Mary's comments were in a similar venue, "I don't have discipline problems because it's so active. And the kids know that if I have to remove them from the group, they only get to watch. They don't want to do that, they always want to participate. The rapport is pretty good, I think." While the mentees were more likely to discuss fun and enthusiasm in terms of student rapport, the mentors also attributed structure as an integral part of bonding with students.

Modeling strategies for effectively teaching science was another category expressed by the participants within the study. Many of these comments pertained to hands-on activities. Mary responded to the question about demonstrating hands-on lessons in this way, "Yes, every time I have had people come in and watch me. That is all we do in here is hands-on. I had some people observe me on Friday. I was doing touchy-feely tanks. I have the Florida Educator's Aquatic Species Collectors License. I can go to the ocean or the lagoon, collect specimens, and bring them in. I know it is not like an experiment. I had two swimming pools in here because I moved all my tables to that end. I had all different kinds of organisms in each pool and I talked about it with the kids. It was a lot of fun." Her mentee, Karen, confirmed this incident as she shared how she helped Mary to set up the lab.

Mentor modeling of classroom teaching strategies was evident in other mentees' responses. As Angie described, "So, I had a chance to be in the room with her before the sixth day count and the classes were rearranged. So, her scenario is very interactive with the kids. Whether they are doing an example or an experiment where they are trying to find toothpicks on a multi-colored cloth. Everything she (Kendra) does to teach the kids is very hands-on." Cora described her observations of her mentor in terms of a few incidents, "Only in faculty demonstration scenarios with the exception of when I volunteered for her in a summer science camp about two summers ago. She was at the stage when they (the students) were assembling science boards. So I was able to see how she helped them to prepare their boards." Due to the fact that the mentees were full time teachers, they did not have opportunities to watch their mentors as often as they would have liked. As Karen shared, "I have not been in Mary's room a lot because we are at two different schools. But one way she has helped me was by showing me how to do the journals, which I didn't do this year, but I will next year. She also helped me a lot with the primary grades so that I could focus on those process skills. Especially like observing. She does a lot of observing and drawing at the primary level especially with kindergarten."

Modeling effective classroom management was another component presented by each mentor. In discussing classroom management, Mary recounted, "Generally what happens is, they (the mentee) say, 'can I come and observe you?' So, I don't prep them ahead of time. They come and they watch me. When the kids are gone, I will sit and talk to them and ask them do they have any questions about what they observed. There's no real formal thing, but anytime they are observing me they can see that I don't raise my voice. One of things I do is I say, 'If you can hear my voice raise your right hand, if you are looking at me, raise your left hand.' So, they (students) have both hands up, then I'll say, 'If you are doing both of those things, you may put your hands down.' Whatever they have in their hands is down, and I have their attention right away. I model that with lots of people."

Lori shared, "I establish from day one how I want things done. The moment they (students) walk into the class, we are grouped. I have already done some prior checking on skills so I have capable students grouped with those students who might struggle because we are a full inclusion school." She continued to emphasize her method by adding, "I model this for teachers. Even if the teacher did not have some kind of labeling procedure, working with that many students I would give them 3D." Lori described 3D as a form of cooperative grouping which arranges students of different levels together for classroom activities. She felt this form of classroom management was highly effective within the science classroom and contributed to a positive environment and few discipline problems. Kendra advocated this teaching technique as an effectual means towards managing the science classroom; however, she stated she didn't "really teach the teachers how to do the cooperative groups and hands-on stuff" but modeled it continually.

Feedback

The fifth factor in the mentoring model was feedback. Five questions pertaining to this factor were asked of the participants, the responses were aggregated into three themes: types of feedback, quality of feedback, and evaluative feedback. Types of feedback mentors provided to their mentees were indicated in Mary's response, "Oral communication, email, phone calls, and person to person conferencing. With written communication, I email. With verbal communication, I might review a lesson plan and make comments on a lesson plan…. I am certainly not at a loss for words. If they ask me a question or my advice, I give it to them openly. If there's something I like, I will tell them I am going to use that in my lab."

These types of feedback were reverberated in the mentees' responses when Angie shared, "Just talking to each other and notes. We are very open with each other about what is happening and what is not… usually through emails, notes, and phone calls." When queried about the frequency of the feedback she received from her mentor, Angie responded, "No, it's kind of whenever we see each other. She always asks, 'How did it go? How did your stuff go?" Karen also communicated frequent interactions with her mentor, Mary, via phone calls, emails and visiting each other after school. Of the three mentoring dyads, Cora initially denied receiving oral or written feedback from her mentor, Carol, but in a later response admitted, "I did get some written feedback in the form of emails. She would stick her head in now and then and watch what I was doing. Then she would email me and say great job on such and such or whatever."

The quality of feedback given to the mentees appeared to be more highly valued than the frequency. Angie stated, "She's given me a lot of good notes about it. When she came in and looked at my lesson, she left little notes about it. Positive, saying you did great on this and look for this a little more." Karen also recounted similar events, "I got lots of feedback. She even had to back me up a couple of times with the administration. She said I was doing a good job and that I was doing exactly what I should be doing." Karen readily acknowledged, "Mary and I have gotten really close this year. I am very comfortable in talking to her about what worked and what didn't work." In developing a trusting relationship with her mentor, Karen was able to openly discuss her practice and receive feedback. Within Carol and Cora's relationship, both individuals spoke of numerous exchanges related to science fair and "science types of things". Carol described her feedback to her mentee by sharing, "My mentee is a veteran teacher; it is not like she is a new teacher. I share things like, 'That is a cool idea'."

Of the five mentors who were interviewed, only Lori had been in a position to provide feedback as a result of evaluating her mentees' performances. As she stated, "It was my responsibility to evaluate them. We had to work together. We brought in trainers for them on the actual skills they should be using and then it was our job to follow up in the classroom and actually evaluate. We would examine, 'Where are you and how comfortable are you?' This was part of our job to evaluate them." This was not the case with the other four mentors nor was Lori in a position to evaluate the fourth grade teacher who she was mentoring during the period of the study. Kendra encapsulated the notion of evaluative feedback in this way, "No, I don't evaluate my mentees, but I think that is what my administrator wants me to do."

Of the five factors for effective mentoring in elementary science, those questions pertaining to feedback provided a minimum amount of data. However, evident within the dyads were frequent and multiple conversations pertaining to aspects of teaching in which the mentor provided some form of feedback to the mentee.

Summary of Findings

Verbatim interview data, observations, and field notes from the study provided the researcher with thick, rich descriptions of mentoring roles and perceptions of the five-factor mentoring model. Of the eight subjects within the study, five were mentors and three were mentees affording three mentoring dyads with two additional mentor perspectives. From these perspectives emerged three themes related to the role of the mentor: emotional support, technical support, and educative support.

Each mentor and mentee voiced attributes pertaining to each theme so that illumination of the roles revealed no one mentor set within a certain pattern of behavior. For the mentors, the aggregate of statements focused on technical support (n= 34) while emotional support comments (n= 19) and educative support remarks (n= 12) were not as abundant. The mentees tended to voice more emotional support concerns (n= 16) than technical (n=13) or educative (n=12). Although there were slightly more observations reported concerning emotional support, this did not appear to be more strongly favored. A numerical display of responses further underscored the emphasis placed on types of behaviors. The researcher was able to use this form of data analysis in better understanding the perceptions relayed by the participants.

Two overarching themes emerged in relation to mentoring roles. The commitment of the mentor and a mentor's flexible role within the relationship were noted as two related, meaningful concepts affecting each mentor and mentee. Mentors demonstrated commitment by providing time, energy and resources to their novices within the context of emotional, technical, and/or educative support. The adaptive supporting roles depended on the nature of each mentoring relationship.

Related to the role of the mentor was the investigation into each subject's perception of the five-factor mentoring model within elementary science. Data revealed the five factors of personal attributes, systems requirements, pedagogical knowledge, modeling and feedback with corresponding themes. Much of the data pertaining to mentoring roles overlapped with the emergent themes since these concepts were intertwined.

Personal attributes revealed two broad themes of support and expert status. Similar to information obtained about each mentor's role, a mentor illustrated support through a willingness to model, providing positive feedback, helping the mentee feel comfortable teaching science, instilling confidence and being available. Also found within the role of the mentor was expert status. Mentors and mentees noted the importance of a mentor's knowledge, the mentor's ability as an effective teacher, and the mentor's passion for teaching.

The four remaining factors within the mentoring model also disclosed similar themes related to mentoring roles. System requirements spoken by the participants focused on district guidelines, state standards, and general aims which underscored the mentor's expert status level in effectively relaying this information. Pedagogical knowledge included aspects of technical and educative support such as timetabling, teaching strategies, pedagogical viewpoints as well as emotionally supportive themes like providing resources and problem solving. The fourth factor of modeling revealed three emergent themes of enthusiasm, student rapport, and classroom teaching strategies. These themes were also reverberated within other factors as well as the mentor's role. The fifth factor of feedback elicited the least amount of comments from the participants and emerged as types of feedback, quality of feedback and evaluative feedback.

Interrelationships between factors and mentoring roles appeared to be a common thread throughout the process of data analysis. These mutual traits led to an understanding of effective mentoring within elementary science that is exemplified within Figure 3. This figure synthesized the findings of the five-factor model and role of mentor. Although the figure separated the five factors by column, each column's themes incorporated aspects of mentoring roles that paralleled the themes or provided a meaningful connection to another factor. For example, when presenting findings pertaining to the factor of feedback, reflection did not emerge as a theme; however, within the role of educative support, reflection was a vital component for effective mentoring and illustrated a type of feedback since the mentors queried "how did it go" or "what do you think went well?" Given the types of reflective responses offered by the participants, this appeared as a type of feedback by which the novice could evaluate her teaching practice.

Personal attributes of support and expert status were illuminated within several columns. For instance, mentors and mentees mentioned emotional support through examples of providing positive feedback, providing resources, or helping a novice feel comfortable with teaching science. The notion of support as positive feedback was also an example of the fifth factor of feedback and was listed under that column due to its parallel nature. The mutual sharing listed under pedagogical knowledge also suggested flexible mentoring roles of technical and educative support since ideas and concepts were exchanged that could promote more effective teaching strategies and ultimately impact student learning. When helping a novice feel comfortable in teaching science, the mentor provided resources and modeled science lessons which were described as beneficial towards improving teacher efficacy.

The additional context chart of figure 3 was included since it represented a more comprehensive depiction of effective mentoring strategies in elementary science combining mentor roles with the five factors. Although similar to figures 1 and 2, the significant difference for figure 3 is that it combines all aspects of data into a more meaningful whole representing what the mentors did in order to positively impact their mentees. Furthermore, this figure was utilized as a component for validating the research as the researcher employed an outside reader to follow the chain of evidence. The outside reader was first exposed to this figure as a culmination of data collection and from that venue the methods were cross-referenced with resulting evidence.

Through the continual reading and re-reading of data, the themes emerged intertwined and interrelated. Mentoring appeared as a complex activity requiring a flexible set of skills and knowledge on the part of the mentor as well as a willingness to demonstrate what was known. Within the next chapter, conclusions from the analysis will be presented pertaining to the mentor's role within elementary science and the five-factor mentoring model. In addition, recommendations for future study and implications for practice will be offered.

Personal Attributes	System Requirements	Pedagogical Knowledge	Modeling	Feedback
• Friendly • Open-minded • Promotes comfort and confidence in teaching science • Passionate about teaching science • Views novice as a learner • Commitment to mentoring • Flexibility • Available	• Knowledgeable about district and state expectations and guidelines	• Coaches via sharing or telling • Mutual sharing of ideas • Collaborative planning • Shared vision of teaching • Knowledgeable about timetabling, assessment, teaching strategies, problem resolutions	• Demonstrates enthusiasm • Demonstrates how to do science in the classroom • Demonstrates strong student rapport	• Positive • Reflective • Not evaluative

Figure 3: Factors for Effective Mentoring

CHAPTER FIVE- CONCLUSION

> *I would like to say again that at first you think it (mentoring) would be only something a new teacher would need, but clearly as much change as there is and the way that everything seems to change, to have a mentor-type person available to talk with is really something valuable. It helps the teacher's confidence when you are insecure about change in teaching science (Cora, 2009, mentee-participant).*

What types of attributes contribute towards effective mentoring in elementary science? In the above quote, the mentee described the importance of trust and communication with a knowledgeable mentor in the context of developing proficiency within the ever changing field of elementary science. The mentee's perceived "insecurity" when teaching science at the elementary level is a ready and all too familiar theme within the literature (Appleton, 2008; Duschl, Schweingruber & Shouse, 2007; Koch & Appleton, 2007; Hudson, 2005; Rowell & Gustafson, 1993). Factors attributed to teacher insecurities range from a teacher's lack of science content knowledge to struggles with presenting rigorously challenging pedagogical knowledge (Appleton, 2008). In addition, lack of encouragement, limited materials for science experiments at the school, cultural expectations emphasizing subject areas other than science, the time involved in establishing effective routines, and few elementary science professional development opportunities contributed towards a lack of expertise (Rowell & Gustafson, 1993). In order to address these deficits, mentoring has been suggested as a possible venue towards alleviating hesitancy and subject avoidance within elementary science (Hudson, 2004; Koch & Appleton, 2007). Identifying effective mentoring behaviors that promote positive changes within an elementary science protégé was the focus of this study.

Summary of the Study

In Chapter I of this study mentorship was postulated as a viable means towards strengthening professional development (Hargreaves & Fullan, 2000). In the area of elementary science, mentorship may promote pedagogical discussions, increase understanding of science content as well as provide the novice with much needed personal support (Gustafson, Guilbert, & MacDonald, 2002). Identifying effective mentoring practices specific to elementary science was a key component in promoting a positive mentoring experience (Hudson, 2004, 2005, & 2007) and underscored the rationale of this study. Utilizing a conceptual framework based on the five factor mentoring model developed by Hudson (2004) with an embedded notion of educative mentoring (Feiman-Nemser, 1998), three questions were developed to guide the study.
(1) What was the role of an elementary science mentor? (2) What were elementary science mentors' perceptions of their practices in relation to the five-factor mentoring model? (3) How did the mentees perceive the practices of their mentor in relation to the mentoring model? Derived from the conceptual framework, these questions were foundational in constructing the interview questions for participants as well as focusing the analysis.

The participants were five elementary teacher mentors and three mentees who were purposively selected based on recommendations of gatekeepers. The research was conducted on the assumption that gatekeepers who were school administrators could identify and nominate competent elementary science mentors based upon selected criteria.

Chapter II contained a review of the relevant literature surrounding five propositions: (1) Elementary science had been impacted by reform movements which had affected classroom practice (2) Professional development opportunities were one means of addressing change in education, in particular was an individualized form of professional development known as mentoring. (3) Cultural perspectives surrounding mentoring had influenced its practice especially in light of the notion of educative mentoring. (4) In elementary science, certain mentoring practices were cited as effective in underscoring professional development. (5) The qualities of mentorship noted within the five-factor model ascribed by Hudson (2004) provided a venue for effectual mentoring practices.

Chapter III described the research methodology for the study as qualitative in nature. A case study design was chosen since it allowed the researcher to enter the perceptions of the mentors and mentees. A modified snowball sampling technique resulted in eight teachers: five mentors and three mentees. Two interviews per individual were conducted utilizing a structured protocol. These responses were audio taped and transcribed. In addition, the researcher was able to conduct observations of interactions between two mentoring dyads during the interviews. These observations were added to field notes. Descriptions of the participants were included in order to provide readers with greater insight into the individual's role within the study. Analysis of responses was based on Miles and Huberman's (1994) technique involving data reduction, data display, and conclusion drawing/verification. The process of analysis included the use of researcher developed matrices and context charts based on existing codes within the literature for the five factor mentoring model (Hudson, 2004) as well as Feiman-Nemser's (1998) notion of educative mentoring and Wang and Odel's (2001) roles of mentors.

In Chapter IV, the findings were sorted into two sections. Within the first section, data suggested three mentoring roles: emotional support, technical support and educative support with two overarching themes of a commitment to mentoring and flexible mentoring roles. In the second section, the five factors for effective mentoring in elementary science were examined. Within each factor, related behaviors were coded and grouped into themes. These five factors were personal attributes, system requirements, pedagogical knowledge, modeling and feedback. The mentors' perceptions were noted and combined with each mentee's observations in order to explore and describe mentoring practices.

Within Chapter V, the conclusions derived from the findings were noted in an effort to report traits for effective mentorship within elementary science. These conclusions were based on analysis of field notes, observations, and interviews with the eight participants of the study and were viewed through the lens of the study's conceptual framework. The guiding questions framed the discussion for Chapter V. Additionally, recommendations for future study and implications for practice were presented.

First Guiding Question

The first question of the study pertained to the role of an elementary science mentor. When examining the roles of mentors, certain traits and behaviors were consistently demonstrated (see Figure 1). These traits appeared within each individual to some degree and were organized around three different but supporting roles found within the literature. Mentors assisted their protégés through emotional support, technical support, and/or educative support. The notions of emotional and technical support were derived from data within the study and affirmed research by Wang and Odell (2007) in their description of mentoring roles. These roles were ascribed from three different perspectives; humanistic, situated apprentice, and critical constructivist.

A humanistic mentoring perspective illustrated “a counseling process” (Wang & Odell, 2007, p. 475) in order to assist the novice in solving problems and building personal confidence. The mentor needed strong interpersonal skills involving good listening, encouragement, and nonjudgmental attitudes. This perspective was coded as emotional support within the study. The second perspective of situated apprentice supported the mentee by connecting theory learned at the university with actual classroom practice. Mentors were expected to not only be knowledgeable but articulate that knowledge and provide novices with increasing levels of responsibility. Situated apprentice was renamed technical support within the study. The third description within Wang and Odel’s research, the critical constructivist mentor, was not evidenced within participating mentors except as it pertained to mentor/mentee conversations about a “vision of learning and teaching”. Notwithstanding, these types of discussions within the dyads combined with other traits were better illustrated within the role of an educative mentor (Feiman-Nemser, 1996). Educative mentoring relied on reflective practice, shared notions of good teaching, collaboration and was based on the concept of the novice as a learner who constructed and reconstructed knowledge for teaching (Feiman-Nemser, 2001). This perspective on mentoring was coded educative support within the study.

The mentor in the emotional supportive role provided positive feedback, helped to develop a friendship, was open-minded, and assisted the novice in feeling comfortable when teaching science. These categories were noted within an article by James Rowley (1999) entitled "The Good Mentor". As an effective communicator with strong interpersonal skills, the mentor was able to "capitalize on opportunities to affirm the human potential of their mentees" (p. 21). These opportunities came either "in public settings or private conversations". For the mentees within the study, emotional support through positive feedback helped bolster teacher efficacy. When combined with a friendly and open relationship in which the novice was supported in her efforts to teach science, the mentors may have positively influenced their protégés professional development. This finding supported Hudson's (2005) conclusions about the effect of mentors on their mentees. Hudson contended characteristics of mentors had a direct bearing on the quality of mentorship. The mentor's personal approach promoted comfort levels which encouraged open discussions and built rapport. According to Hudson, this enhanced the novice's confidence for teaching.

Scherer (1999) noted two categories in supporting protégés. 1] Psychological support designed to improve teacher efficacy and 2] instructional support that would promote effective classroom practices. Both categories were noted within this study. The second category emerged as another theme mentors enacted as a part of their roles. Labeled as technical support, four types were mentioned: expert status of mentor, nuts and bolts of teaching, demonstration or modeling, coaching via sharing or telling. While the mentees comments were more equitably distributed amongst all three themes, the mentors offered the greatest amount of statements pertaining to technical support. Koch and Appleton (2007) suggested effective mentoring utilized “cooperative teaching frameworks” in which the mentor relayed expertise within the meaningful context of classroom practice. Within their study, the mentors, who were two university professors, worked with elementary teachers on developing and implementing a physical science inquiry unit. As recognized experts, the professors were able to promote the development of new knowledge, skills, and deeper scientific understanding. They attributed these positive effects to a situated learning context. Through modeling and coaching, novice learning was enhanced. Parker-Katz, and Bay (2008) also attributed a situated-learning context to more efficient learning for the mentee. They suggested this context could lead to sustained conversations about practice which were critical in assisting mentees to construct knowledge about teaching.

The third theme that emerged related to the role of the mentor was educative support. First coined by Feiman-Nemser (1998), educative mentoring reflected not only the psychological and instructional supports noted by Scherer (1999) but broadened the role of mentoring to include ideas about how teachers learn their craft and ways to promote that process. Within the study, educative support included the perspective of the novice as a learner, shared visions of teaching, mutual sharing, collaborative planning, and reflective practice. Although the fewest amount of statements pertained to this type of mentoring, the findings did affirm the research presented by Feiman-Nemser (1998, 2001) and Norman and Feiman-Nemser (2005). In this role, each person contributed to the relationship through a sharing of knowledge, respect, and "mentoring as joint work" (Feiman-Nemser, 1998, p. 67). Mentors within the study suggested reflective practice as a means towards improving instruction and utilized "finding openings" and "pinpointing problems" as dialogic techniques for promoting conversations about science teaching and learning. The notion of the mentee as a learner was only openly expressed by the mentoring dyad of Carol and Cora. These two participants articulated the mentoring relationship as a way to "learn the process" by "jumping in and doing it together" as the mentor shared what "she knew and how she knew it". Norman and Feiman-Nemser (2005) described the reciprocal element of their relationship as a blend of "showing and telling, asking and listening in ways that promoted new teacher learning" (p. 680).

The two overarching themes revealed through participant responses were a commitment to mentoring and the flexible role of the mentor. Both themes underscored relevant research presented within the literature (Appleton, 2008; Koch & Appleton, 2007; Norman & Feiman-Nemser, 2005; Schavarien & Cosgrove, 1999; Schwille, 2007). Fullan (2001) described commitment in the form of moral purpose defining the term as "acting with the intention of making a positive difference in the lives of employees, customers, and society as a whole" (p. 3). For the teachers within the study, it was the hope of making a positive difference in the lives of students and their mentees that drove their commitment. Each mentor voluntarily gave up substantial amounts of time to work with another individual in an informal situation that was not assigned by the administration or institution. The amounts of time varied depending on the context of the relationship and all of the dyads represented mentoring occurring "around the edges of teaching" (Feiman-Nemser, 1996, p. 72) since the participants did not have sizeable amounts of time in each other's classrooms.

Lack of time was noted within several studies as an issue contributing to weak mentoring relationships (Katz, Sadler, & Craig, 2005; Schavarien & Cosgrove, 1999; Schmidt, 2008). Hargreaves (1994) posited, "Time as a fundamental dimension through which teachers work is constructed and interpreted by themselves" (p. 95). In examining the political and cultural aspects of time in schools, he explained, "Time for the teacher is not just an objective, oppressive constraint but also a subjectively defined horizon of possibility and limitation." (p. 95) With the exception of Lori's description of mentoring within a magnet school, the politics of time appeared to be a concern for most of the mentors in this study. The mentors expressed a sincere desire to work with their mentees but voiced lack of time as an "oppressive constraint".

In her study of a failing music teacher who successfully received tenure after working with several mentors, Schmidt (2008) conjectured a strong need for mentors "to invest time in observing and listening" to their protégés and in "comparing what novices say with their observed teaching practices" (p. 645). Through time spent with a novice, mentors could build open, trusting relationships that encouraged the discussion of pedagogy. Time offered the "possibility" of building an effective mentorship or limited its effects. Although time constraints were a complaint offered by the mentors of the study, the mentees suggested the notion of mentor availability as one supporting thread to the relationship. The mentors apparently were able "to invest time" wisely.

Combined with the notion of a deep commitment to mentoring, the study's findings also suggested the mentors were flexible in their interactions with novices. Flexible mentoring roles allowed the mentors to move in and out of their roles in order to become "shared leaders" in planning for student learning (Hargreaves & Fullan, 2000). Schwille (2008) described learning to mentor as "a process of developing a practice based on a conceptual stance toward mentoring" (p. 143). In her cross national study of mentoring pre-service and beginning teachers, Schwille noted effective patterns of mentoring included a large repertoire of skills which were improvised and adapted to suit the situation and the novice's learning while relying on the individual mentor's strategic knowledge and judgments. Each mentor within the present study provided multiple examples of different roles enacted within the mentoring relationship. This moving in and out depended on the context of the relationship. When describing mentoring situations involving small groups or limited mentoring engagements, the mentors ascribed a more technical stance; however, within the intimate dyad relationships, mentoring for emotional and educative support was more clearly evident.

In ascertaining mentoring roles, data revealed three emergent themes as well as two overarching themes. These themes overlapped with other findings pertaining to participants' perceptions of five-factor mentoring. The five factors for effective mentoring within elementary science were personal attributes, system requirements, pedagogical knowledge, modeling, and feedback.

Second Guiding Question

The second guiding question for the study queried elementary science mentors' perceptions of their practices in relation to the five-factor mentoring model. The findings from data revealed each factor indicating related characteristics that corresponded to more than one category (see Figure 3). In the area of personal traits, support and expert status emerged as two broad themes. These themes were also found within the mentors' roles; however, the type of questions pertaining to personal attributes focused participant responses more narrowly. Being supportive was a key characteristic ascribed by mentors and mentees alike. This finding underscored Hudson's (2004) conjecture that the mentor's ability to foster effective science teaching within the novice was a significant personal attribute. This was accomplished through a supportive stance utilizing positive comments and constructive feedback in order for the mentee to feel more confident.

The second emergent theme within the factor of personal attributes was the expert status of the mentor. Much of the literature espoused the importance of a knowledgeable mentor (Gustafson et al., 2002; Hudson, 2004, 2005, & 2007; Koch & Appleton, 2007; Schavarien & Cosgrove, 1999). The findings of this study also suggested mentors and mentees placing great worth on the expert status of the mentor. Each novice discussed the primary goal in seeking out a mentoring relationship was to gain greater expertise about some aspect of elementary science. In order to do this, they asked each mentor for assistance. The mentors concurred with this perspective, suggesting it was their knowledge and abilities as effective teachers that led each mentee to them. This contradicted Hargreaves and Fullan's (2000) supposition of the mentor as a sage passing along knowledge to a young novice becoming an antiquated model. They argued for a new view of mentoring that changed mentorship from a "hierarchal dispensation of knowledge" to a perspective incorporating "shared inquiries into practice" (p. 55). While the teachers within this study did report a mutual sharing of knowledge, they also appeared to highly value the mentor as a "sage" within elementary science.

The second factor of system requirements was illustrated by every mentor through technical assistance. The mentors adamantly spoke of state's standards and district's guidelines when helping the mentee to develop lessons. In fact, two mentors, Lori and Mary, assisted with modifications to Florida's new standards for elementary science during the previous summer. The outlining of district policies and curriculum guidelines was an effective mentoring practice noted by Hudson, (2004), Jarvis et al. (2001) and Shea and Greenwood (2007). Through discussions of these essentials, mentees could begin to comprehend how system requirements were to be practiced within a school and classroom setting. Throughout conversations with all five mentors, the importance of utilizing these documents was repeatedly emphasized. In addition, safety policies were discussed but did not seem as greatly stressed as the standards and district guidelines. This emphasis was noted within Hudson and Savarien-Genser's (2009) results using the Mentoring for Effective Science Teaching instrument with Turkish teachers. Mentors were quick to point out science curriculum documents with less emphasis on other school policies, and even less likely to discuss the general aims of science as it related to developing a scientifically literate population.

Pedagogical Knowledge, as the third factor within Hudson's (2004) model, revealed patterns of providing resources, teaching strategies, timetabling, assessment, pedagogical viewpoints, and problem solving. The mentors described practical means of aiding the novices through setting up carts with materials or suggesting resources while also discussing teaching strategies such as cooperative learning. Subject specific pedagogical knowledge such as choosing an appropriate hands-on activity for a science concept or probing for student understanding after a science demonstration were intertwined within each mentor's conversations.

Although the literature pertaining to mentoring within elementary science was extremely narrow, the main purpose of every study was to promote specific pedagogical knowledge within the novice (Appleton, 2008; Hudson, 2004; Jarvis et al., 2001; Koch & Appleton, 2007; Picket & Frasier, 2002; Schavarien & Cosgrove, 1999; Shapely and Luttrell, 1992). Findings from the present study helped to challenge the argument that all mentoring was generic since the essence of what mentors relayed to their mentees related to elementary science. Jarvis et al. (2001) contended subject specific mentoring improved pedagogical content knowledge (PCK) within the novice. Teachers with greater PCK were more likely to surmise and address students' misconceptions, create and implement appropriate lessons, and "correctly interpret pupils' insightful comments" (p. 7).

One key difference in responses between mentors and mentees was discussion and emphasis on assessment. Each mentor was more likely to discuss the annual state FCAT science exam especially in relation to state standards and district pacing. This may have been attributed to each mentor's position within the school since three of the mentors were science activity teachers who were responsible for teaching fifth graders while another mentor was a fifth grade teacher and the last mentor, Lori, discussed mentoring teachers at a low performing magnet school. The annual state science FCAT is an important exam within Brevard County for comparing students' performance between schools, districts and the state. Great emphasis is placed on the teacher's responsibility for instructing students in a manner that will promote understanding which is believed to be reflected in high scores on the science FCAT.

Modeling was the fourth factor within the five factor mentoring model. Through demonstrating classroom practices, novices were provided "living examples" of educational theory (Feiman-Nemser, 2001). Patterns within the data related to modeling revealed four categories: demonstrating science lessons, a positive rapport with students, enthusiasm, and classroom management. The most frequently described science practice was hands-on lessons. Shapely and Luttrell (1992) attributed the following mentoring practices: "familiarizing teachers with science processes, conducting appropriate hands-on activities for teaching those processes, and immediately putting the activities into practice in the teachers' own classrooms" (p.11) towards positively impacting elementary teachers' science efficacy. Feldman et al., (1999) also posited the modeling of hands-on science as effective in impacting novice teaching practices.

Mentor modeling of appropriate pedagogy was not only an example of one factor within the model designed by Hudson (2004) but was perceived by the participants as a means of demonstrating emotional support for teaching. Hudson suggested effective mentors tended to "display a confidence and enthusiasm for teaching science that can be infectious" which in turn supported the novice's transition from "pre-service teacher to teacher" (p. 32). For the mentees within the study, it may have been the modeling of this kind that contributed to feelings of support and encouragement.

The fifth factor for the mentoring model was feedback. The feedback provided to the mentees came in the form of oral or written responses. With the exception of Lori's experience at the magnet school, each mentor denied utilizing feedback as a means towards evaluation. Even Lori's present mentoring situation with the fourth grade teacher did contain an evaluative component. Types of feedback included emails, notes, phone calls, or face to face meetings. From the mentors' discussions most of the feedback was positive affirmations related to a mentee's instructional activity. According to Hudson (2005), constructive feedback contributed to teacher efficacy within elementary science. This type of support was suggested as a critical factor in helping the mentee with the demands of teaching, if the feedback was "accurate, diagnostic, and as timely as possible" (Moberg, 2008, p. 96).

Although most of the mentors stated they did not look over the mentees written plans, they did admit to frequent discussions with a mentee about some component of a science lesson. One reason for limited feedback may have been due to lack of access and time spent with the mentee during actual classroom instruction. This disadvantage did not allow for each mentor to observe the content of the novice in action as well as limited, if not prohibited, utilizing mentoring as a "think aloud" activity. Feiman-Nemser (2001) stipulated the importance of not only modeling teacher behaviors for the novice but also explicating the actions in order to avoid assumptions of novice understanding about a teaching experience. She advocated "experiential learning situations" (p. 25) in which the mentor thinks aloud while the mentee observes her conducting a lesson or solving a problem.

The five factors for effective mentoring within elementary science appeared evident within the conversations of each mentor. Each mentor favored her own style of mentoring and richly expressed a passion for teaching science. As a part of this strong sentiment, a commitment and enthusiasm for mentoring was illuminated through their statements. Mary encapsulated this view when she relayed, "Eventually, my dream job would be to mentor teachers in science…I do like working with the children, but I enjoy more working with teachers and helping them teach science."

Third Guiding Question

The third guiding question for this study addressed mentees' perceptions of their mentors' practices within the five factor mentoring model. The mentees' conversations served to corroborate the perceptions of the mentors plus helped to provide greater consistency to the study. Within each factor, the mentees largely agreed with their mentors' discussions and conveyed to the researcher a deep sense of respect for the teacher mentor.

The personal attributes described by Hudson, Skamp, and Brooks (2005) and Hudson and Savarien-Genser (2007) were listed as supportive, promoting teacher efficacy, listening attentively and reflectively, and promoting comfort in discussing and teaching science. These characteristics were reported by mentees of this study either within the factor of personal attributes or through the role of the mentor. Hudson et al, (2007) described a mentor's ability to listen attentively and then help the mentee reflect required a level of comfort when talking about science. The mentees within the study also described their mentors' willingness to discuss science teaching and learning. The mentees acknowledged feeling supported and more confident. Stanulis and Russell (2000) attributed feelings of trust and support through mentoring conversations in which a protégé's knowledge could be constructed and reconstructed. However, within interviews of the present study, mentees were more likely to admit the mentor's ability to develop a friendship and their openness to various ideas underscoring the relationship. It may have been these "nuanced description of interactions" (Norman & Feiman-Nemser, 2005, p. 681) revealed within the conversations of mentees that contributed to differing patterns within data when compared to findings within Hudson's research.

The "nuanced descriptions" also revealed protégés preferences for characteristics that not only supported them but provided professional knowledge of science teaching. Novice comments within the study suggested proportional amounts of statements pertaining to emotional support and that of a knowledgeable mentor. This finding did not concur with Whittaker's (2000) assessments of novices' perceptions of effective attributes in mentors. According to her study, the novices felt personal characteristics such as warmth, caring, open-mindedness, and availability was more important than a mentor's expert status. Her participants suggested psychological support was more valuable than technical assistance. While these characteristics were valued by the mentees within this study, they also considered expertise equally important.

Some discrepancies within this study's data existed between what a mentor shared and what the mentee perceived such as availability. For this attribute, the mentors appeared conflicted due to time constraints, yet willingly gave up their time, while the mentees conceived availability in terms of reassurance. Cora stated, “Through her availability I never feel like I am in this alone.” Many teachers, new to the profession, often complain of feeling isolated in addition to struggling with other issues such as curriculum, classroom management and school culture (Feiman-Nemser, 2003). Schavarien and Cosgrove (1999) suggested it was the availability of the researcher that contributed to the novice’s learning since easy access allowed for in-depth and purposeful discussions pertaining to pedagogical content knowledge (PCK). As a mentor within their study, Lyn Cosgrove was available for lengthy discussions, questions, and collaborative planning. From this time spent, the researchers posited significant changes in science teaching practices of the individual mentees. However, it should be noted that the quality of available time was as important as the quantity.

The second factor of system requirements within the model revealed similar results as the surveys conducted by Hudson et al. (2005) and Hudson et al. (2007). The mentees within this study described their mentors emphasizing state and district requirements. Karen jokingly admitted, “We (she and her mentor) have gone over them (the standards) extensively. I figure one more year and I will be able to quote them verbatim.” Hudson (2005) noted the importance of novices’ practical understanding of state and district mandates when attempting to implement these directives within daily classroom science lessons. Clear input from an individual with professional knowledge of science directives would assist a protégé in executing more effective instruction (Shea & Greenwood, 2007).

Pedagogical knowledge, a third factor within the mentoring model, revealed mentees voicing comparable attributes to those perceived by their mentors. When examining the responses through multiple lenses of mentoring roles and factors, pedagogical knowledge (see Figure 3) included coaching, mutual sharing, collaborative planning, a shared vision, as well as those themes pertaining to expert status such as knowledgeable about timetabling, assessment, teaching strategies and problem solving.

The notion of collaborative planning ascribed within the role of the educative mentor (Feiman-Nemser, 1998) was not clearly evident within Hudson's research (2004, 2005, & 2007) nor was it a component of every mentoring dyad within the present study. This form of mentoring could allow mentors "to participate with the mentees in social activities that have meaningful products" (Feiman-Nemser, 1998, p. 68). The social activity of collaborative planning was an authentic task which helped to create science lesson plans for daily classroom use. For Karen, a mentee, this way of planning seemed to be the norm within the relationship since she and her mentor would "get together with their laptops" on a weekly basis in order to write lesson plans. However Angie's experiences were different since she shared of frequent discussions with Kendra (her mentor) in which they "worked hand in hand" but did not relate these statements to lesson plans except when she received a positive comment about a lesson. The third mentee, Cora, did not discuss collaborative planning; however, her relationship with her mentor centered on the annual science fair and science projects more than on daily science lessons. Notwithstanding, Cora's description included an educative element when she said, "She (Carol) does not tell me, but guides me."

In Appleton's (2008) study of two teachers mentored in elementary science certain attributes related to pedagogical knowledge emerged. As a "critical friend and helper", the mentor/researcher cooperatively planned a science unit with the teachers. When the plans were implemented, Appleton worked with the teachers on aspects of science PCK by utilizing a "think aloud" strategy. As a mentor, he provided "expert knowledge for the teacher", "challenged the teachers' current teaching practices", presented "alternate views of teaching and learning" and provided support as a "classroom helper" (p. 538). The findings of the present study indicated similar mentor practices perceived by the mentees. The protégés noted each mentor's expert status and ability to articulate information about science teaching and learning. Two of the mentees discussed sharing a vision of teaching with their mentors. For Karen, this discussion presented alternate views related to the use of full inquiry within the science classroom. In Angie's case this discussion did not appear to present an alternate view, but challenged her practice "to be where she needed to be". Furthermore, the mentors within the study were perceived as "classroom helpers" through the provision of resources and coaching.

Appleton's (2008) research also pinpointed the importance of effective modeling when mentoring to impact PCK. Aspects of modeling perceived by the mentees within the study included a mentor's enthusiasm, student/teacher rapport, and demonstration of science lessons including classroom management. These reports did not differ from the mentors' observations of their practices. When demonstrating enthusiasm whether it was during teaching or in a rapport with students, the participants quite often attached the word "fun". The notion of fun while learning was discussed by Orvis and Orvis (2005) when addressing students' misconceptions in a chemistry course. They contended lively engagement was a valuable tool for overcoming conceptual difficulties. Students learned more when they actively participated. Appleton (2003) connected the notion of student learning, interactive activities, and novice teachers. He suggested a major contributing factor for hesitancy in science teaching was limited science PCK. However, when teachers frequently utilized hands-on, engaging, "fun" activities, these became part of their science PCK. The mentees within this study were quick to note the engagement levels of students during the fun activities and appeared to associate this with the mentor's enthusiasm for teaching science.

Mentees' perceptions of the fifth factor of feedback corresponded with the mentors. For the mentees, positive feedback was important in building confidence. Feedback was not only an emotionally supportive theme but when it encouraged reflecting, it underscored the theme of educative support. Primarily, this reflective feedback was informal as the mentees' described it happening "whenever" the individuals "saw each other". Questions such as "how did it go?" or "how was it for you?" were suggested by the mentees as one way the mentors helped them to ponder a recent science lesson. While it is noteworthy that the mentors assisted the mentees with some type of reflection, the depth to which the mentees were asked to reflect on their practices was not a finding of this study. Norman and Feiman-Nemser (2005) suggested one important role mentors can play is to help the novice focus on students' "mind activity" in order to access prior knowledge, build meaningful connections, and promote understanding. Since most mentees' concerns were related to their own actions and not the students, reflecting on student learning became a venue for accessing "mind activity". Through this reflection, the novice could be led to interpret "what their students say and do and figure out how to move their learning forward" (p. 680). This form of reflection did not emerge within the present study's findings with the exception of one comment by a mentor (Mary) who said, "We have the time to discuss how things went or what happened when students did this or that." However, Mary did not provide enough insight into the direction of student learning in order for the researcher to determine the depth of reflection practiced by the participants.

The concluding remarks within this section were organized around the guiding questions in an effort to address the purpose of the study. The intent was not to generalize the findings reported here to the experiences of all mentors or even to all elementary science mentors. The purpose of the study was to explore and describe qualities of effective mentorship within elementary science. Findings within data revealed the roles enacted by the mentors as well as factors ascribed by Hudson (2004, 2005, & 2007) for effective mentoring. Mentors were characterized as friendly, open, and trusting individuals whose commitment to their novices underscored all subsequent actions. Elementary science expertise was a highly valued commodity and the ability to articulate that knowledge as well as emotionally support the protégé proved to be vital components of mentorship. One surprising finding was the degree to which the mentors adapted their roles depending on the context of the relationship and the needs of the novice. When compared to the literature, many of the findings corroborated those presented by researchers while other findings offered differing perspectives. In this way, the descriptive nature of the study added to the literature by portraying the nature of individuals participating within the mentoring process, offering insights about the relationships of mentors and mentees in their school settings, as well as illuminating aspects peculiar to the phenomenon of mentoring in elementary science. Additionally, this study added to a very narrow literature base for mentoring within elementary science and offered teachers a pragmatic view of effective mentoring practices.

Implications for Further Research

During analysis of data and conclusion drawing, additional aspects for research became apparent. Researchers may wish to further expand this study by:

1. School administrators and the district's elementary science resource contact were the gatekeepers within this study. In this position, they were asked to identify effective mentors within elementary science. Utilizing surveys and/or personal interviews with the gatekeepers could add another dimension to this study perhaps further clarifying effective mentoring practices.
2. The scope of this study was limited to one school district and involved a small sample size (n=8). Conducting case studies with several comparable school districts could yield a diversity of participants' voices and experiences and possibly produce different results.
3. The mentee participants of the study were teachers ranging from 2 to 15 years of experience. This was not always the case for other studies examining perceptions of preservice teachers as mentees. Examining the roles of elementary science mentors when working with preservice teachers versus those roles when working

with veteran teachers may offer additional insights about the flexible nature of mentorship.

4. While this study focused on specific traits for effective mentoring, the effect of those traits on the practices of mentees was not investigated. Conducting a follow-up study that examined the mentor's impact on each mentee's classroom practices and how these practices affected student learning could provide valuable insight into mentoring as a form of professional development.

Concluding Remarks

The nuanced differences in the roles of the mentors contributed a distinct flavor to mentorship and affirmed the uniqueness of each mentoring dyad. Within the dyads, all the protégés positively affirmed mentoring as a means towards promoting teacher efficacy within elementary science. And they whole-heartedly endorsed mentoring as an avenue for developing practice. Given the voluntary nature of each mentoring relationship, it may have been the individual mentor's role that was a key determinant for each mentee's successful experience. At no time were any of the mentees pressured into seeking a mentor nor were they obligated to continue participation in the relationship. Yet, each mentoring dyad averaged approximately a year's length in time. There was no formal end to each relationship since the dyads appeared to have developed friendships beyond mere collegial support.

What the researcher did not observe or interpret from conversations with each participant was the power differentials described within some of the literature (Colley, 2002; Mullins, 2005;

Sundli, 2006). One mentee, Karen, alluded to it as a possibility that did not occur when she shared, "The very first time we met, I was thinking she (her mentor, Mary) knew more than I did, but she made me very comfortable very quickly. She gave me a lot more self-confidence." Given the hierarchical nature of mentoring relationships, the researcher anticipated this aspect of traditional mentoring to reveal itself within the participant's interviews. This was not the case, perhaps because the nature of the dyads within the study was voluntary and not assigned with evaluative criteria. Another important component that may explain the lack of power differentials were the mentoring roles incorporated into the relationship. The flexibility within these roles seemed to encourage reciprocity. Mentors and mentees mutually shared ideas and visions of teaching as equals. With this type of rapport, power elements may have been minimized, if not negated.

The roles of the mentors within the study were surprising similar. Each person illustrated an individual who was enthusiastic about teaching and sharing elementary science expertise with others. Each mentor voluntarily gave up enormous amounts of time to work with another individual in an informal situation that was not assigned by the administration or an institution. All five mentors desired to see reform-minded practices such as hands-on activities and cooperative grouping implemented within the mentees' classrooms and were committed to promoting these practices through technical assistance, educative, and emotional support. Williams (2001) claimed, "understanding the passion of teachers who have managed to maintain enthusiasm and commitment to teaching in an era of disillusionment about education and a time when quantitative measures are dictating the important work of teachers in the individual classroom" (p. 76) could reveal self-renewing aspects of effective teachers and mentors. Within this study, the researcher was repeatedly amazed at the level of commitment and the degree of enthusiasm the mentors demonstrated. These mentors did not appear disillusioned but energized through the mentoring relationships.

Although political and social demands cry for reform within education and while numerous studies have offered the potential of mentoring as a "change force", mentoring within elementary science has not been openly promoted (Appleton, 2008; Hudson, 2004, 2005, & 2007; Jarvis et al., 2001; Koch & Appleton, 2007; Picket & Frasier, 2002; Schavarien & Cosgrove, 1999; Shapely and Luttrell, 1992). Fullan's (1993b) description of a "change force" revealed "the actions of individuals and small groups working on new conceptions intersect to produce breakthroughs" (p. 2). The individuals and dyads within the study were committed toward "working on" the improvement of science education within the elementary classroom. While improvement of teaching practices is not a "new conception", the "breakthroughs" noted within findings of the study yielded strong professional relationships that endorsed mutual sharing, respect for knowledge, and a desire to enhance student learning. During a time when individual teachers are examined and compared to other teachers based on students' annual test scores, professional collaboration is at an all time low (Williams, 2001). Concepts of change and reform were not openly discussed by the participants, and yet notions pertaining to reform were implied through verbatim data. In this manner, the mentors were a "change force" within their small circles of influence. It may be these small circles of influence which will ultimately produce larger breakthroughs.

APPENDIX A: Letters Requesting Subject Participation

Appendix A-1 Letter to Gatekeepers

Appendix A-2 Letter to Mentors

Appendix A-3 Letter to Mentees

Appendix A-1 Letter to Gatekeepers

University of Central Florida

Dear _____________,

My name is Joyce M. Smolik. I am a doctoral student in the College of Education at the University of Central Florida guided by Dr. Bobby Jeanpierre, a UCF faculty supervisor in Teaching and Learning Principles. I am also an elementary school teacher in Brevard County. The topic of my research concerns the behavioral characteristics and beliefs of experienced teachers who mentor elementary teachers in the area of science. The title of the study is "A Case Study of Elementary Science Mentoring Experiences". The superintendent of Brevard County has granted permission to conduct this study.

I am asking for your permission to recruit and to help with the recruitment of those exemplary mentor teachers who are experienced in assisting new or veteran teachers with elementary science. You will be asked to identify one or more exemplary teacher mentors. To aide you in your selection please consider the following criteria: The exemplary teacher should:

- Currently teach in the school district
- Have five or more years of experience as a teacher here or elsewhere
- Have served as a formal or informal mentor in the area of elementary science.

To further enhance your ability to make this identification I invite you to refer to the qualities of effective mentors in four skill areas described by the National Foundation for the Improvement of Education (fall, 1999).

1. Attitude and Character- Teachers who:
    - have a desire to be a role model for other teachers
    - exhibit strong commitment to the teaching profession
    - believe mentoring improves instructional practices
    - demonstrate a commitment to lifelong learning
2. Professional Competence and Experience- Teachers who:

- are regarded by colleagues as outstanding teachers
- possess excellent knowledge of science pedagogy and subject matter
- demonstrate efficient classroom management skills
- understand the policies and procedures of the school, district and state

3. Communication Skills- Teachers who:
    - articulate effective instructional strategies
    - listen attentively
    - offer critique in positive and productive ways
    - convey enthusiasm and passion for teaching science
4. Interpersonal Skills- Teachers who:
    - maintain trusting professional relationships
    - have the ability to care for a protégé's emotional and professional needs
    - are attentive to sensitive political issues
    - are approachable and demonstrate good rapport with others

It is my belief that administrators are in a good position to identify outstanding teacher mentors in schools because it is you who have the experience and responsibility of supervising and evaluating teachers.

Please nominate, with the permission of the individual, as many teachers as you feel match these descriptors. Once identified by you, I will contact these individuals to request two sixty minute interviews. The teacher interviews will help me to gather data about the attributes of exemplary mentors, their beliefs about effective science instruction, and their beliefs about mentoring.

The names of the participating teachers will not be reported to you. Participation is voluntary and can be withdrawn at any time. All participants in this study will receive a copy of the abstract upon request.
The confidentiality and anonymity of all interviews of participating teachers will be preserved. This information will be used solely for the purpose of analysis. All notes and tape recordings will be destroyed three years after the conclusion of the study. Prior to that, all notes and recordings will be kept in a locked file cabinet in my home.

It is my hope this study will enhance understanding of the qualities, proficiencies, and beliefs held by exemplary mentor teachers in the area of elementary science. Whether or not you decide to nominate teachers for this study, I am requesting you complete and return the enclosed reply form via courier to Joyce Smolik at Oak Park Elementary.

Study contact for questions about the study or to report a problem: Joyce M. Smolik, Graduate Student, Curriculum and Instruction Program, College of Education, (school contact- Oak Park Elementary, 269-3252 extension 5027 or by email at smolikj@brevardschools.org) or Dr. Bobby Jeanpierre, Faculty Supervisor, Department of Teaching and Learning Principles at (407) 823-4930 or by email at bjeanpie@mail.ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

How to return this form to the researcher: Please sign and return this form in the enclosed envelope and send via courier to Joyce Smolik, Oak Park Elementary. A second copy is provided for your records. By signing this letter, you give me permission to report your responses anonymously in the final manuscript to be submitted to my faculty supervisor as part of my course work as well as contact your assistant principal for his/her input and the nominated elementary science mentors.

Sincerely,
Joyce M. Smolik

Administrator Reply Form

_______ I do volunteer to involve my school in the research presented on the preceding page. I have identified the following individuals as exemplary mentor teachers in the area of elementary science.

______________________________ ______________________________

______________________________ ______________________________

______________________________ ______________________________

________ I do not elect to involve my school in this study.

Signature of administrator/supervisor ____

Date ______________________________

Please return this form within the addressed courier envelope to:

Joyce M. Smolik

Appendix A-2 Letter to Mentors

Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 20 people. You can ask questions about the research. You can read this form and agree to take part right now, or take the form home with you to study before you decide. You will be told if any new information is learned which may affect your willingness to continue taking part in this study. You have been asked to take part in this research study because you are a teacher who mentors in elementary science education. Your name was provided by your administrator who has approved this study as well as asking your permission to recommend you as a possible participant. You must be 18 years of age or older to be included in the research study and sign this form.

The person doing this research is Joyce M. Smolik of the University of Central Florida and an elementary teacher in Brevard County. Because the researcher is a doctoral student, she is being guided by Dr. Bobby Jeanpierre, a UCF faculty supervisor in Teaching and Learning Principles.

Study title: A Case Study of Elementary Science Mentoring Experiences

Purpose of the research study: The purpose of this study is to examine effective mentoring practices in elementary science.

What you will be asked to do in the study: You will be asked to commit to two interviews. The purpose of the interviews is to gather data about the attributes of effective mentors in elementary science, effective instruction in science education, expectations for protégés, and beliefs about mentoring. The length of each interview will be approximately sixty minutes.

In addition to your interviews, the researcher would also like to collect data from one of your protégés about the mentoring experience. In order to accomplish this, the researcher respectfully requests you share the name and school of your mentee on the attached form. Please ask the mentee's permission before providing the name. This additional perspective will contribute towards the triangulation of data accumulated for this study.

Voluntary participation: You should take part in this study only because you want to. There is no penalty for not taking part, and you will not lose any benefits. You have the right to stop at any time. Just tell the researcher or a member of the research team that you want to stop. You will be told if any new information is learned which may affect your willingness to continue taking part in this study.

Location: The location of the interviews will be at your school or another site convenient for you and the researcher.

Time required: The time needed to conduct this study will involve two sixty minute interview sessions as well as the time needed to complete the consent form.

Audio or video taping: You will be audio taped during this study. If you do not want to be audio taped, you may not be able to be in the study. Discuss this with the researcher or a research team member. If you are audio taped, the tape will be kept in a locked, safe place until what you say has been written down. Once it is written down, the tape will be erased or destroyed.

Risks: There are no expected risks for taking part in this study. You do not have to answer every question or complete every task. You will not lose any benefits if you skip questions or tasks. You do not have to answer any questions that make you feel uncomfortable.

Benefits: There are no expected benefits to you for taking part in this study. As a research participant you will not benefit directly from this research, besides learning more about how research is conducted.

Compensation or payment: There is no compensation or other payment to you for taking part in this study.

Confidentiality: Your identity will be kept confidential. The researcher will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. For example, your name will be kept separate from the information you give, and these two things will be stored in different places.

Your information will be assigned a code number. The list connecting your name to this number will be kept in a locked file cabinet or in a password protected computer. When the study is done and the data have been analyzed, the list will be destroyed. Your information will be combined with information from other people who took part in this study. When the researcher writes about this study to share what was learned with other researchers, she will write about this combined information. The school district of Brevard County has requested a report of the findings, but your name will be de-identified. Your name will not be used in any report, so people will not know how you answered or what you did.

Study contact for questions about the study or to report a problem: Joyce M. Smolik, Graduate Student, Teaching and Learning Principles (or school contact, Oak Park Elementary,

(321) 269-3252 extension 5027, (407) or Dr. Jeanpierre, Faculty Supervisor, Department of Teaching and Learning Principles (407) 823-4930 or by email at smolik.joyce@brevardschools.org.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

How to return this consent form to the researcher: Please sign and return this consent form in the enclosed envelope via courier to Joyce Smolik at Oak Park Elementary. A second copy is provided for your records. By signing this letter, you give me permission to report your responses anonymously in the final manuscript to be submitted to my faculty supervisor as part of my course work.

□ I have read the procedure described above □ I agree to be audio taped

□ I voluntarily agree to take part in the procedure

□ I am at least 18 years of age or older □ I do not agree to be audio or video taped

_________________________ _________________________ ________

Signature of participant Printed name of participant Date

__________________________________ ____________

Principal Investigator Date

Name and school of elementary teacher protégé ______________________________

____

Appendix A-3 Letter to Mentees

University of Central Florida

Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 20 people. You can ask questions about the research. You can read this form and agree to take part right now, or take the form home with you to study before you decide. You will be told if any new information is learned which may affect your willingness to continue taking part in this study. You have been asked to take part in this research study because you are a teacher who was mentored in elementary science. Your mentor has provided your name as a possible participant in this study, after asking for your permission to do so. You must be 18 years of age or older to be included in the research study and sign this form.

The person doing this research is Joyce M. Smolik of the University of Central Florida and an elementary teacher in Brevard County. Because the researcher is a doctoral student, she is being guided by Dr. Bobby Jeanpierre, a UCF faculty supervisor in Teaching and Learning Principles.

Study title: A Case Study of Elementary Science Mentoring Experiences

Purpose of the research study: The purpose of this study is to examine effective mentoring practices in elementary science.

What you will be asked to do in the study: You will be asked to commit to two interviews. The purpose of the interviews is to gather data about your elementary science mentoring experience. The length of each interview will be approximately sixty minutes.

Voluntary participation: You should take part in this study only because you want to. There is no penalty for not taking part, and you will not lose any benefits. You have the right to stop at any time. Just tell the researcher or a member of the research team that you want to stop. You will be told if any new information is learned which may affect your willingness to continue taking part in this study.

Location: The location of the interviews will be at your school or another site convenient for you and the researcher.

Time required: The time needed to conduct this study will involve two sixty minute interview sessions as well as the time needed to complete the consent form.

Audio or video taping: You will be audio taped during this study. If you do not want to be audio taped, you may not be able to be in the study. Discuss this with the researcher or a research team member. If you are audio taped, the tape will be kept in a locked, safe place until what you say has been written down. Once it is written down, the tape will be erased or destroyed.

Risks: There are no expected risks for taking part in this study. You do not have to answer every question or complete every task. You will not lose any benefits if you skip questions or tasks. You do not have to answer any questions that make you feel uncomfortable.

Benefits: There are no expected benefits to you for taking part in this study. As a research participant you will not benefit directly from this research, besides learning more about how research is conducted.

Compensation or payment: There is no compensation or other payment to you for taking part in this study.

Confidentiality: Your identity will be kept confidential. The researcher will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. For example, your name will be kept separate from the information you give, and these two things will be stored in different places.

Your information will be assigned a code number. The list connecting your name to this number will be kept in a locked file cabinet or in a password protected computer. When the study is done and the data have been analyzed, the list will be destroyed. Your information will be combined with information from other people who took part in this study. When the researcher writes about this study to share what was learned with other researchers, she will write about this combined information. The school district of Brevard County has requested a report of the findings, but your name will be de-identified. Your name will not be used in any report, so people will not know how you answered or what you did.

Study contact for questions about the study or to report a problem: Joyce M. Smolik, Graduate Student, Teaching and Learning Principles (or school contact, Oak Park Elementary, (321) 269-3252 extension 5027, (407) or Dr. Jeanpierre, Faculty Supervisor, Department of Teaching and Learning Principles (407) 823-4930 or by email at smolik.joyce@brevardschools.org.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

How to return this consent form to the researcher: Please sign and return this consent form in the enclosed envelope via courier to Joyce Smolik at Oak Park Elementary. A second copy is provided for your records. By signing this letter, you give me permission to report your responses anonymously in the final manuscript to be submitted to my faculty supervisor as part of my course work.

□ I have read the procedure described above □ I agree to be audio taped

□ I voluntarily agree to take part in the procedure

□ I am at least 18 years of age or older □ I do not agree to be audio or video taped

____________________________ ____________________________ ________

Signature of participant Printed name of participant Date

_____________________________________ ____________

Principal Investigator Date

APPENDIX B: Interview Protocol

Appendix B-1 Initial Interview Questions for Mentors

Appendix B-2 Culminating Interview Questions for Mentors

Appendix B-3 Initial Interview Questions for Mentees

Appendix B-4 Culminating Interview Questions for Mentees

Appendix B-1 Initial Interview Questions for Mentor

A. Role of Mentor

1. Talk a little bit about your background. What has brought you to where you are today in teaching?
2. What kinds of mentoring in elementary science have you experienced?

B. Personal Attributes

1. Do you perceive yourself as an effective science teacher? What kind of characteristics do you display that would demonstrate this?
2. Do you feel comfortable in talking to your mentee about science teaching? Please elaborate.
3. In what ways have you attempted to instill within your mentee a positive attitude towards teaching science?
4. Have you had opportunities to assist the mentee in reflecting on his/her science practices? Elaborate on these experiences.
5. In what ways have you enabled your mentee to feel more confident about teaching science?
6. What types of communication have you used in relating to your mentee what he/she needs to improve for teaching science?

C. System Requirements

1. Have you had opportunities to discuss the district's elementary science curriculum guide with your mentee? What kinds of things did you discuss?
2. What kinds of school policies used for science teaching have you shared with your mentee?

D. Pedagogical Knowledge

1. Do you have opportunities to guide your mentee with science lesson preparation? Please describe what you did.
2. In what ways have you assisted your mentee with classroom management strategies for science teaching?
3. In what ways have you assisted your mentee with implementing science teaching strategies?

4. Have you assisted your mentee with timetabling/pacing science lessons? Describe this experience.
5. In what ways have you assisted the development of your mentee's strategies for teaching science?

E. Modeling

1. Have you had opportunities to model science teaching for your mentee? Describe a scenario(s) of your modeling.
2. Do you believe you demonstrate enthusiasm when teaching science? How would you describe yourself during science instruction?
3. Do you believe you have modeled for your mentee effective classroom management when teaching science? Please describe what you have done.

F. Feedback

1. What kinds of oral feedback have you provided to the mentee concerning his/her science teaching?
2. What kinds of written feedback have you provided your mentee about his/her science teaching?
3. Are there any additional comments you have about the mentoring experience?

Appendix B-2 Culminating Interview Questions for Mentors

A. Role of Mentor

3. Why do you mentor?
4. How would you describe your role as a mentor?

B. Personal Attributes

7. In your relationship with your mentee, how did you demonstrate support for teaching science?
8. In what ways was being a mentor hard?
9. Have you ever had a mentoring experience that did not go well? Please describe this experience.
10. What is important about being a mentor that was not discussed in the first interview?

C. System Requirements

3. What kind of state science curriculum documents have you discussed with your mentee?
4. Have you discussed with your mentee the aims of science teaching? Elaborate on this discussion.

D. Pedagogical Knowledge

6. Have you had opportunities to discuss questioning skills with your mentee? What kind of things did you discuss in reference to questioning?
7. What kinds of knowledge needed for science teaching have you discussed with your mentee?
8. What types of guidance have you provided for your mentee about planning for science lessons?
9. When discussing a mentee's science teaching problems, what types of strategies have your suggested?
10. Do share various perspectives on teaching elementary science with your mentee? What kinds of viewpoints have your discussed?
11. In what ways have you showed your mentee how to assess students' learning of science?

E. Modeling

4. Please describe your rapport with your students while doing science.
5. Have you used hands-on materials with your students while modeling science instruction for the mentee? Describe this experience.
6. How do you perceive the science activities you design for your students?

F. Feedback

3. Have you had opportunities to review a mentee's science lesson plans before they teach the lesson? Please describe this experience.
4. Do you observe your mentee teach science before providing feedback? Please explain.
5. Is there anything about the mentoring experience you would like to comment on.

Appendix B-3 Initial Interview Questions for Mentees

Initial Interview Questions for Mentees

A. Role of Mentor

1. Talk a little bit about your background. What has brought you to where you are today in teaching?
2 What kinds of mentoring in elementary science have you experienced?

B. Personal Attributes

1. Do you perceive you mentor as an effective science teacher? What kind of characteristics did he/she display that would demonstrate this?
2. Do you feel comfortable in talking to your mentor about science teaching? Please elaborate.
3. In what ways has your mentor attempted to instill a positive attitude towards teaching science?
4. Has your mentor assisted you in reflecting on your science practices? Elaborate on these experiences.
5. In what ways has your mentor enabled you to feel more confident about teaching science?
6. What types of communication has your mentor used in relating what you need to improve your teaching science?

C. System Requirements

1. Have you had opportunities to discuss the district's elementary science curriculum guide with your mentor? What kinds of things did you discuss?
2. What kinds of school policies used for science teaching has your mentor shared with you?

D. Pedagogical Knowledge

1. Have you had opportunities to work with your mentor on science lesson preparation? Please describe what you did.
2. In what ways has your mentor assisted you with classroom management strategies for science teaching?

3. In what ways has your mentor assisted you with implementing science teaching strategies?
4. Have your mentor assisted you with timetabling/pacing science lessons? Describe this experience.
5. In what ways has your mentor assisted you with the development of strategies for teaching science?

E. Modeling

1. Have you had opportunities to watch your mentor teach science? Describe the scenario(s).
2. Do you believe your mentor demonstrates enthusiasm when teaching science? What does that enthusiasm look like?
3. Describe some of the effective classroom management techniques for teaching science you have seen your mentor do.

F. Feedback

1. What kinds of oral feedback has your mentor provided you concerning teaching elementary science?
2. What kinds of written feedback has your mentor provided you about teaching elementary science?

Appendix B-4 Culminating Interview Questions for Mentees

Culminating Interview with Mentee

A. Role of Mentor
   3. Why did you seek a mentor?
   4. How would you describe her/his role as a mentor?

B. Personal Attributes
   7. In your relationship with your mentor, how did he/she demonstrate support for teaching science?
   8. What were some of the benefits from this mentoring experience?
   9. Are there any negative aspects to the mentoring experience that you would like to discuss?
   10. What is important about the mentoring experience that was not discussed in the first interview?

C. System Requirements
   3. What kind of state science curriculum documents have you discussed with your mentor?
   4. Have you discussed with your mentor the aims of science teaching? Elaborate on this discussion.

D. Pedagogical Knowledge
   6. Have you had opportunities to discuss questioning skills with your mentor? What kind of things did you discuss in reference to questioning?
   7. What kinds of knowledge needed for science teaching have you discussed with your mentor?
   8. What types of guidance has your mentor provided you about planning for science lessons?
   9. When discussing science teaching problems you have encountered, what types of strategies has your mentor suggested?

10. Does your mentor share various perspectives on teaching elementary science? What kinds of viewpoints have your discussed?
11. In what ways has your mentor showed you how to assess students' learning of science?

E. Modeling
4. Please describe your mentor's rapport with students while doing science.
5. Have you observed your mentor using hands-on materials with students? Describe this experience.
6. How do you perceive the science activities your mentor designs for students?

F. Feedback
3. Has your mentor had opportunities to review your science lesson plans before you teach the lesson? Please describe this experience.
4. Does your mentor observe you teach science before providing feedback? Please explain.
5. Is there anything about the mentoring experience you would like to comment on?

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