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Coaching For Change: Amount of Instructional Coaching Support to Transfer Science Inquiry Skills from Professional Development to Classroom Practice

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COACHING FOR CHANGE: AMOUNT OF INSTRUCTIONAL COACHING SUPPORT TO TRANSFER SCIENCE INQUIRY SKILLS FROM PROFESSIONAL DEVELOPMENT TO CLASSROOM PRACTICE

by

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The use of instructional coaching as a follow-up component to high-quality professional development experiences is being used to improve classroom instruction to meet the requirements of NCLB and promote organizational change. The purpose of this study was to determine the minimum number of coaching sessions necessary to translate new strategies and skills learned during a summer institute into classroom practice.

Teachers attended a 2-week summer institute focusing on the development of guided science inquiry as both an instructional strategy as well as a content. During the following school year, teachers implemented a unit lasting approximately 6–8 weeks focusing on the newly learned guided inquiry strategies and skills. Teachers video-recorded their classroom instruction and uploaded their videos to their instructional coach. Both the teacher and the coach reviewed the classroom video prior to meeting for distance-delivered coaching sessions approximately one to two times per week during the unit implementation. Teachers were assigned to an instructional coaches with strong science content knowledge and extensive classroom experience at the level the teachers were implementing their units. Each recorded coaching session was approximately 45 minutes in length and was conducted with a strengths-based skills approach. Coaching

sessions continued until coaching support was jointly terminated by the teacher–coach pair.

Findings in this study suggest that the teachers need a minimum of eight to nine coaching sessions to begin to effectively implement inquiry approaches into their instructional practice. These conclusions came from two sources of data: (a) teacher and coach inquiry teaching confidence measures conducted after each coaching session; and (b) independent coder assessment of teacher performance from two, 4-level inquiry observational rubrics ranging from non-inquiry to exemplary inquiry. The total amount of contact time between teacher and coach was observed from the recorded coaching sessions. Teachers and coaches spent approximately 7 hours in one-to-one coaching sessions during the implementation of their inquiry unit. However, these data suggest no meaningful relationship between contact time and teacher performance.

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Introduction

"Our nation's long-term economic prosperity depends on providing a world class education to all students, especially in mathematics and science," according to U.S. Education Secretary Arne Duncan (Armario, 2011). However, the American population is simply not producing the quality of student that can compete on a global scale. This problem continues to grow as even fewer students have developed the skills leading to careers in science and technology.

U.S. students perform miserably compared to international counterparts (National Science Board, 2012). Of 56 countries, students in nine countries are higher achievers in science than in the U.S. (Provasnik et al., 2012). The 2011 National Assessment of Educational Progress (NAEP) indicates that 35% of eighth-graders have a "below basic" understanding and only 32% of eighth-graders have a "proficient" understanding of science. Further, results from 2011 NAEP show that students in the U.S. "… do much better identifying the correct answers to simple scientific tasks than using evidence from their experiments to explain those answers" (Parnass, 2012).

Schools and teachers are among the key players in shaping the future success of our educational systems. Comprehensive changes in what schools and teachers see as their roles in the educational process are essential to schools adapting their operations to meet the needs of both children and adult learners. Certainly, the process of change is a slow one, taking much time and effort. "The power of the status quo is great, but the challenge is worthy of our efforts" (Levinson, 1990, p. 126). The key players in facilitating change are the schools—both administrators and teachers—and the state and local agencies that fund public education.

David (1991) points out that leaders in every state have committed their administrations to the challenge of restructuring their public school systems, a challenge that has no hope of success without appropriate implementation strategies and effective in-service training of the educational professional in the field.

President Bush set up the America 2000 objectives to put America first in the world in quality education, but achieving such status will not come without change. The No Child Left Behind Act (NCLB) was signed into law on January 8, 2002. The declared purpose of the act is to ensure that "all children have a fair, equal, and significant opportunity to obtain a high-quality education…" (Tokic, 2006). Title II of the act provides a plan for preparing, training, and recruiting high-quality teachers. In 2009, President Obama furthered the educational reform agenda by establishing the largest amount of discretionary funding ($4.35 billion) for K–12 education in the history of the United States when he outlined his Race to the Top (RTTT) competitive grant program. The Obama administration set aside funds to accomplish four major goals: (1) to encourage schools to adopt standards that prepare students for success in college and careers; (2) to monitor improvement in student achievement and identify effective instructional practices; (3) to boost the quality of teachers and principals; and (4) to turn around the lowest-performing schools through staff and leadership that changes school culture (Duncan, 2009). Race to the Top is "fundamentally about two things: creating political cover for state education reformers to innovate and helping states construct the administrative capacity to implement these innovations effectively" (McGuinn, 2012, p. 137).

Darling-Hammond (2000) concluded that teacher influence has the greatest impact on student performance. She further indicated that the impact of ineffective teachers has a long-term detrimental impact on students, especially when students experience ineffective teaching

for a year or more. These students are often unable to catch up with their peers who have had the benefit of more effective instructors. Repeated exposure to the same teachers is especially common in smaller, more rural school districts where one teacher is responsible for teaching all of the grade levels of a specific content like math or science.

The importance of continued professional development of the classroom teachers has never been greater. Compliance with the requirements of NCLB are challenging for many districts, but the circumstances of rural districts create unique challenges. The small populations and geographical isolation of many rural schools and districts greatly affect access to resources, thereby affecting a school district's ability to build the capacity necessary to comply with NCLB (Reeves, 2003). Many rural schools have difficulty in recruiting and retaining teachers, especially those in high needs areas. Research shows that such factors as school leadership and teacher empowerment have a powerful effect on both increasing student achievement and improving teacher retention (Darling-Hammond & Berry, 2006).

In Nebraska, 87 percent of the school districts meet the current National Center for Educational Statistics' definition of a "rural setting" and more than 12 million children attend schools in a rural setting across the United States (Kena, Aud, Johnson, Wang, Zhang, Rathbun, Wilkinson-Flicker, & Kristapovich, 2014). Children in rural areas are disadvantaged educationally as many rural schools experience high poverty, low student achievement, few advanced course offerings, low teacher salaries, and uneven distribution of funds (Johnson, Showalter, Klein, & Lester, 2014; Johnson & Strange, 2007). Accounting for nearly 20 percent of all public school students in the United States, more than "two in five of those rural students live in poverty, more than one in four is a child of color, and one in eight has changed residences in the previous 12 months" (Johnson, Showalter, Klein, & Lester, 2014, p. 28).

Research Problem

For rural science teachers, geographic and professional isolation coupled with great distances from "local" opportunities make access to professional development (PD) in science even more difficult. Further limiting for middle and high school rural science teachers is the fact that often there is only one science teacher in the building. Consequently, it is very difficult for these science teachers to be out of the classroom for even a short period of time and there is no immediate "community of practice" available for those teachers who are required to be knowledgeable and proficient in all science areas in multiple grade levels (Lave & Wenger, 1991).

"Studies show that long-term, in-depth methods of teacher learning are the most successful, but few professional development opportunities exist for teachers in rural districts, and access to university-sponsored resources is also limited. Rural teachers and schools are often invisible as they are dwarfed by the needs of larger urban districts in dense population areas" (Wilson & Ringstaff, 2010, p. 44). "Access to quality professional development, especially intensive science summer institutes, often requires teachers to pay for room and board because of the travel distance. Professional development during the school year often requires driving long distances after a full day of teaching. Moreover, resources from universities and colleges are often beyond geographic reach" (Wilson & Ringstaff, 2010, p. 44).

The demographic characteristics of rural schools and districts affect the availability of funding and access to programs, services, and training opportunities. This lack of access plays a large role in the ability of rural districts to build local capacity to comply with NCLB (Reeves, 2003). Distance learning has been proposed as a strategy for alleviating many of the

problems rural schools face in providing a comprehensive curriculum and training teachers. As years of research have shown (Gillies, 2003; Johnson & Johnson, 1999; Webb, 1982), students perform better when they learn in a structured setting that includes regular interaction with their teacher and their peers. This is also true for teachers participating in professional development. Training is more effective when it is prolonged and hands-on. Interactive technology also has the potential to increase professional development opportunities available to rural teachers by overcoming the obstacle of distance and by allowing teachers to more fully participate in interactive training sessions without the need to leave their school. A study entitled Distance Education Use in Rural Schools (Hannum, Irwin, Banks, & Farmer, 2009, p. 11) reports that a "large majority of rural school districts (69%) were already using some form of distance education, and a substantial portion (85%) had used distance education in the past." Rural schools have indicated "considerable satisfaction" with distance education experiences and are using it to address the challenges of geographic isolation and limited resources (Johnson & Strange, 2007, p. 12).

Rural schools further experience significant challenges in providing effective professional development opportunities for teachers due to limited availability of professional development resources and the lack of available staff to support professional development efforts (e.g., coaches, consultants, substitute teachers for release time). It is clear that the professional development efforts that employ a "train and hope" philosophy, without attending to transfer to practice, are ineffective and insufficient at transferring new knowledge and skills to applied settings (Sparks, 2002). Despite this, short-term and one-time training remains the most common form of professional development (Birman, Desimone, Porter, & Garet, 2000; Garet, Porter, Desimone, Birman, & Yoon, 2001).

The lack of success of existing professional development practices is highlighted by Cornett and Knight (2009), who note that implementation of new teaching strategies obtained from the most common professional development ("train and hope") translates into ongoing implementation only about 15% of the time. On the other hand, professional development with follow-up coaching on the new strategy had a successful implementation closer to 85%.

Contemporary approaches to professional development conceptualize utilizing coaching as a means of ongoing support for teachers in ways that are active, collaborative, linked to classroom context, and embedded within school culture (Pianta, Mashburn, Downer, Hamre, & Justice, 2008). The use of coaching as a method for developing instructional professionals is becoming more prominent (Ingersoll & Kralik, 2004; Pianta, 2005). Coaching via distance technologies can help to mitigate some of the unique challenges faced by rural schools in accessing quality PD resources. As the practice of utilizing coaching becomes more the standard, school leadership is charged with making decisions about type and duration of the coaching support to provide its teachers without adequate data to drive the decision making process. As budget constraints further impact almost all schools' capacity to serve their teachers and, ultimately, students, it is imperative to understand the value of coaching and the required timeframes to optimize the return on the coaching professional development investment.

Research Purpose

The purpose of this research was to better understand the relationship between classroom implementation of new instructional strategies, the duration of ongoing instructional coaching support, and teacher expectations as to the value of an instructional coach. Teachers developed the basic skills to implement scientific inquiry-based instructional strategies and

content during a two-week summer institute that includes the opportunity to practice the new skills learned as well as develop a working relationship, face to face, with their instructional coach. This quantitative research approach will help identify when in the coaching process (e.g., number of sessions) the teacher, coach, and measured teacher performance indicated convergence supporting teacher autonomy in implementing the new instructional skills learned during the professional development experience. Throughout the first year of the *Coaching Science Inquiry in Rural Schools (CSI)* study (discussed later in this chapter), weekly meetings with the instructional coaches were held, focusing on discussions of progress that each participant teacher was making and any special issues that had arisen. Out of these meetings it became clear that there was a point at which the teachers began to develop the ability to self-reflect and direct the implementation of the guided inquiry strategies more successfully without the same degree of coach support. The timeframe from the first coaching session to reaching this point developed what appeared to be a pattern, but based largely on anecdotal data. From the accounts of the coaches, it appeared that the "learning curve" for implementing the coaching support was between three and five coaching sessions, but a definite "end-point" where teachers no longer made substantial improvement in their skills was not easily identifiable by the coaches. Quantitative study was needed to better analyze and understand these relationships and was the impetus for conducting research on the necessary duration for coaching support. In addition to understanding the changes during coaching, *CSI* coaches noted that teachers' prior experiences appeared to affect their expectations that further professional development activities would be valuable. This research further examined how teacher expectancy was related to overall teacher performance levels obtained through the professional development plus coaching support process.

Conceptual Framework

In 1989, Carpenter, Fennema, Peterson, Chiang, & Loef published a landmark study connecting teacher professional development to improvements in student achievement (Sparks, 2002). Ever since that time, professional development has become part of the standard operating practice in almost every school in the country. This development is typically tied to targeting school improvement goals and seen as a mechanism for effecting change within educational systems, ultimately improving student achievement. Sparks further cites Linda Darling-Hammond as noting "…teachers who know a lot about teaching and learning and who work in environments that allow them to know students well are critical elements of successful learning" (p. 14). In many ways, schools model their own goals for their students of being lifelong learners through ongoing professional development efforts, as they spent in excess of $1.5 billion of federal funds on professional development in the 2004–2005 school year (Birman et al., 2007) in addition to local and state investments.

Unfortunately, much of this money spent may be on expenditures that simply do not produce results as there is too little empirical data to link teacher professional development (PD), classroom practice, and student achievement (Ball & Cohen, 1999; Lawless & Pellegrino, 2007). Understanding the connection between strong teacher knowledge and skills, the transfer of the knowledge and skills, and student achievement is paramount to student learning. Despite this need and the increasing demand for improvements in student achievement as well as school-wide accountability for the success of all students, PD programs often present content out of context of the actual classroom setting. Teachers are disenchanted by the "sit and get" delivery approach that fails to focus on teachers' existing skills set or classroom needs. Consequently, there is a disconnect between the new content learned and

subsequent implementation in the classroom (Garet et al., 2001).

Given the vast array of factors that impact student learning, it is essential that professional development efforts focus on both content and processes that promote knowledge acquisition and skills transfer. To provide for meaningful long-term change, the professional development itself should be of sufficient duration and provide a connection with the teachers' and students' realities both inside and outside the classroom walls (Garet et al., 2001), while moving away from the passive learner model utilized so frequently. Instead, the focus needs to move toward knowledge-based, practice-centered support and guidance for teachers (Ingersoll & Kralik, 2004; Pianta, 2005). These development strategies promote the instructional strategies and application of the skills in relevant contexts (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005).

As Opfer and Pedder (2011) noted, teaching and learning do not happen in isolation but rather as a complex network of factors including both teacher variables (e.g., content knowledge, teaching experience) and contextual variables (e.g., content domain, school climate). The model of change (Figure 1) utilized as the framework for *CSI: Coaching Science Inquiry in Rural Schools* was adapted from Desimone's (2009) model of change.

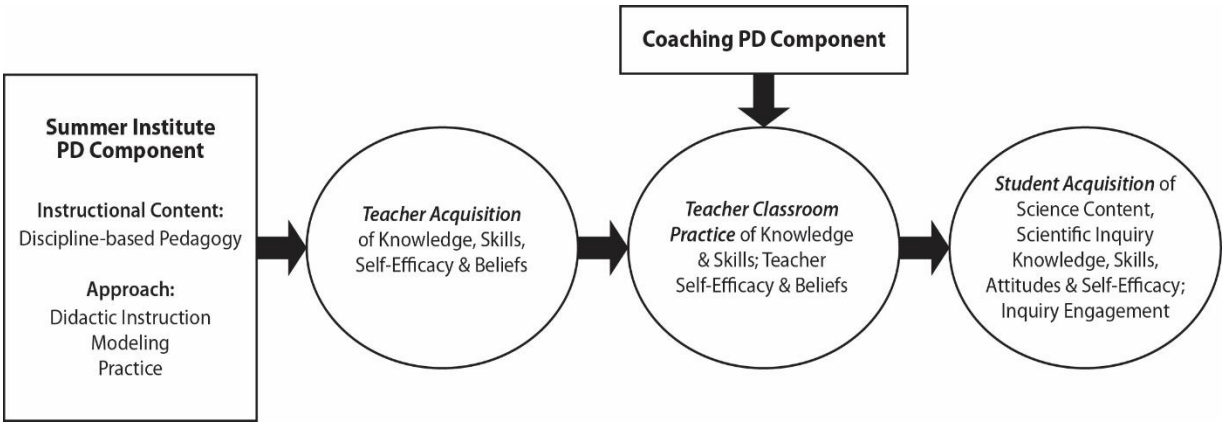

Figure 1. Model of change from teacher professional development (Nugent, Kunz, & Pedersen, 2011)

The large-scale *CSI* study has already been completed with the overall model of change including a summer professional development and coaching component. A large body of research exists on what constitutes high-quality professional development (see literature review in Chapter 2), but relatively little is known about the coaching piece of professional development. Even with sound content knowledge, a myriad of factors impacts the ultimate translation to desired student outcomes. Employment of some type of support medium is frequently useful in fostering the transfer of the teachers' knowledge and skills obtained in the professional development experience to the student learner. The focus of this study was instructional coaching as the medium to support translation of knowledge and skills learned in professional development experiences to classroom practices.

In the larger *CSI* study, the overall process of face-to-face professional development with a follow-up coaching component was studied. The *CSI* model represents a variety of high-quality professional development practices in conjunction with a very specific coaching component to support teachers implementing new classroom practices. *CSI* instructional coaching is positioned as a strengths-based approach that supports teachers' development of the skills necessary for successful implementation of science inquiry instructional strategies. The role of the coach was dynamic and responsive to the specialized needs of the teacher in the classroom, while maintaining the overall objective of implementing science inquiry. Changes in the type of support the coach provided during the coaching process may provide insight into the amount of coaching support necessary for the teacher to be successful without ongoing coaching support.

Collet's (2012) research has developed the Gradual Increase in Responsibility (GIR) coaching model. This model is based on the assumption that all teachers enter the coaching

process with some prior knowledge about the specific content and strategies being supported. Coaches provide varying degrees and types of support that include modeling, recommending, questioning, affirmation, and praising through decreasing levels of scaffolding moving teachers from interdependence to collaboration. The process is a non-linear process that "meanders" as the teacher makes strides towards interdependence at variable rates throughout the developmental process with the support of their coach. Further, the model reflects the periodic setbacks that teachers experience when attempting to implement new strategies and skills into their classroom practices.

Coaching is emerging as one support medium that shows promise for impacting student learning as well (Sailors & Shanklin, 2010). This research focused on the duration of coaching support needed to demonstrate measurable changes in teachers' ability to successfully implement newly learned instructional strategies that support specified student outcomes that can serve as guidance for educational leadership in make decisions about the feasibility of integrating coaching support as a component of professional development processes. (A further review of coaching will be covered in the Literature Review on pages 23 through 43).

One of the underlying objectives of coaching is to elicit changes in behavior. Albert Bandura's work has created a clear link between how an individual thinks (believes) and the role these beliefs play in retaining new behavior patterns (1977). Behavior is developed through modeling followed by self-correcting adjustments based on performance feedback. Long-term changes in behavior develop by observing one's own actions rather than from the examples provided by others. An outcome expectancy (or simply expectancy) is a "person's estimate that a given behavior will lead to certain outcomes" (Bandura, 2010, p. 193). Self-

efficacy (also known as beliefs or confidence) expectation is the belief that one can complete the required behavior to achieve the desired outcomes. "Outcome and efficacy expectations are differentiated, because individuals can believe that a particular course of action will produce certain outcomes, but if they… [have] doubts about whether they can perform the necessary activities such information does not influence their behavior" (Bandura, 2010, p. 193). The degree to which one believes that they can perform the desired behavior impacts their choice to engage in certain activities. In this case, a teacher may believe that they can effectively implement inquiry instruction into their classroom but not believe that the coaching support is necessary or sufficient to provide meaningful feedback to facilitate success. As a result, a teacher that has a lower expectancy as to the value of coach support as part of the professional development process may be less likely to utilize the coaching support to the extent that it provides maximum benefit through feedback and modeling. Further, the long-term impact of the coaching experience is predicted to have a lesser translation to extended changes in behavior without the feedback from the coach. For instructional coaching to be effective in supporting the integration of new instructional strategies and practices into the classroom, the teacher must believe in the need for change as well as in the coach's ability to provide adequate support in the change process. The degree to which these beliefs exist is a measure of the teachers' expectations of the value of coaching support.

Research Questions

Heightened accountability and the increasing pressure for U.S. schools to produce the best and brightest students in the world appears to be here to stay. As schools, districts, and states continue their quest to help students achieve at the highest levels, it is clear that the way teachers teach has to evolve to more closely reflect the ever-changing needs of our students

and our global economy. This type of systemic organizational change does not come without intensive efforts to support the growth and development of the existing teaching staff. Numerous professional development opportunities exist that have varying degrees of impact on student achievement and price tags that span the spectrum. Data-driven decision making is essential as leadership in education approaches the daunting challenge of not only leaving no child behind but also in fully developing the potential of every child. This research study was a starting point for addressing what is required when the medium to foster the transfer of new skills from the PD to the classroom is instructional coaching and addresses the following questions:

1. As perceived by the teachers and confirmed by the instructional coaches, what amount of instructional coaching is optimal for supporting the translation of new strategies and skills acquired in professional development training to increased teacher performance?
2. What is the relationship between the amount of time teachers are engaged in one-on-one coaching support and teacher performance?
3. What relationship exists between teachers' expectancy of the value of follow-up coaching support and the level of teacher performance?

Assumptions

The context of this research piece is within a larger research study, *CSI: Coaching Science Inquiry in Rural Schools* (*CSI*), through the National Center for Research on Rural Education. *CSI* addressed the larger issue of utilizing coaching to support the implementation of inquiry as both a content and instructional strategy. Teachers were recruited to participate in a summer professional development opportunity and follow-up coaching was provided during a 6- to 8-week implementation phase during the following school year. This study

assumes that the science teachers involved in the *CSI* study were participating because they willingly chose to participate in order to be able to become better teachers. As the teachers were offered financial compensation for their participation in *CSI* as well as randomly assigned to treatment and control groups, it is further assumed that this may have helped to alleviate some of the self-selection for participation.

The primary assumption was that teachers wanted to become better teachers and they had the expectation that participation in professional development experiences is necessary to promote changes that are observable in their students' performance. It is hypothesized that teachers that had lower expectations that this would happen participated less fully in the project (specifically the preparation for, reflection on, and participation in coaching sessions) and consequently saw smaller gains in their degree of implementation of the inquiry skills and correspondingly lower levels of student achievement. Coaching provided by an external consultant (i.e., not the teacher's administrator or direct supervisor) allowed for the teachers to take greater risks in implementing new ideas (Habegger & Hodanbosi, 2011; Killion, 2007).

Limitations

This research was an attempt to identify the optimal dosage effect of coaching instructional support provided via distance learning technologies rather than with the teacher and coach being in the same physical setting during the observational timeframe. Further, this study was conducted utilizing secondary science teachers in Nebraska and western Iowa, but it is not clear that the impact of coaching will be generalizable to the teaching population as a whole or that the results found are generalizable to the teaching population in general, across content areas. Finally, the participants in this study were volunteers to participate in the overall *CSI* study. As cited in Lawless and Pellegrino (2007, p. 540):

> Volunteers differ from nonvolunteers in terms of their motivation to learn, their commitment to change, and their willingness to be risk takers (Loughran & Gunstone, 1997; Supovitz & Zief, 2000). The needs of volunteers and nonvolunteers may be intrinsically different from one another.

While teachers were randomly assigned to treatment and control groups, it is not clear why the population of teachers chose to volunteer to participate while others did not, and that question is beyond the scope of this research study. However, the randomized controlled trial (RCT) design of the *CSI* study addresses this issue and allows for more similar treatment and control groups through random assignment.

Delimitations

The research subjects for this study were all selected from schools in Nebraska and western Iowa that currently taught science in schools identified as rural by the U.S. Department of Education, Institute for Education Sciences (IES). These teachers were all participating in a larger randomized control trial, *CSI: Coaching Science Inquiry in Rural Schools* (*CSI*), that focuses on: What is the impact of professional development on guided scientific inquiry with follow-up coaching (treatment) versus no professional development (control) on (a) teacher inquiry knowledge, skills, self-efficacy, and beliefs and (b) student inquiry knowledge, skills, engagement and science attitudes? Each teacher was asked to identify one of nine specific target units for which to implement the inquiry skills they developed through a summer institute. Teachers received unit lesson plans as a guide for implementation of the inquiry strategies and coaching was provided via specific protocols designed by the *CSI* study. Each unit was designed to take a similar amount of classroom time to implement during the school year and coaching intervals were set to one to two sessions per week. The specific content of the coaching sessions was largely teacher driven within the guidelines of the coaching protocol. The Nebraska inquiry standards served as an overarching

theme directing teachers toward the student and teacher outcomes. Likert-type surveys addressing the teachers' confidence in implementing the specific aspects of the inquiry strategy were evaluated at the end of each coaching session by both the teacher and the coach.

Definitions

Terms appear throughout this dissertation that address various facets of educational coaching and accountability in education. The following technical terms are provided as reference in the context of this research.

Professional Development—As cited in the North Central Regional Educational Laboratory (NCREL) website (n.d.), Grant suggests a broader definition of professional development that includes the use of technology to foster teacher growth:

> "Professional development ... goes beyond the term 'training' with its implications of learning skills, and encompasses a definition that includes formal and informal means of helping teachers not only learn new skills but also develop new insights into pedagogy and their own practice, and explore new or advanced understandings of content and resources. [This] definition of professional development includes support for teachers as they encounter the challenges that come with putting into practice their evolving understandings about the use of technology to support inquiry-based learning.... Current technologies offer resources to meet these challenges and provide teachers with a cluster of supports that help them continue to grow in their professional skills, understandings, and interests."

In short, professional development refers to activities that enhance professional career growth. In this study, professional development focused specifically on the transfer of new knowledge and skills about guided science inquiry into the teachers' instructional strategies in such a way as to promote the transfer of knowledge and skills to the student resulting in increased achievement.

Summer Institute—Summer Institutes are extended Professional Development trainings that occur during the non-contract time of classroom teachers.

Instructional Coach—Instructional coaches collaboratively partner with teachers to

choose and incorporate research-based interventions to promote instructional practices that help students learn more effectively.

Guided Science Inquiry—Scientific inquiry is a multifaceted activity that includes making observations, developing testable hypotheses, planning and conducting investigations, sharing and reviewing others' data, analyzing the body of data, proposing and justifying data-based explanations and predictions, and communicating the results of investigations (Committee on Science and Mathematics Teacher Preparation, 2000). Guided scientific inquiry occurs when the teacher engages the students in each of these steps of the process and facilitates the development of scientific concepts through the support of instructional scaffolding.

Secondary Science Teacher—Secondary science teachers teach science in grades 6 – 12 classrooms. While this is not the traditional definition of secondary schools in Nebraska (grades 7 – 12), the 6th grade teachers were included in the definition to allow for the emerging middle school concept that houses grades 6 – 8.

Distance Technologies—Distance technologies, as defined in this study, are communication media that allow for two-way audio and video communication between persons at remote locations. While there are many options available including Polycom, Skype, and Adobe Connect, this study utilizes Cisco WebEx as an internet-based conferencing tool. This system allows for the sharing of audio and video communications in addition to sharing of computer desktop resources to include documents, video files, and other internet-embedded content.

Rural Schools—The National Center for Educational Statistics (NCES) defines each school into categories based on the size of the community in which the school is located as

well as the relative proximity of that community to an area that is urbanized. Rural schools are subcategorized based on their relative distance from the urban area as either being Rural-Fringe (less than or equal to 5 miles), Rural-Distant (between 5 and 25 miles), or Rural-Remote (more than 25 miles). A similar rating system is used for the identification of schools in Towns. Towns are subcategorized based on their relative distance from the urban area as either being Town-Fringe (less than or equal to 10 miles), Town-Distant (between 10 and 35 miles), or Town-Remote (more than 35 miles). Many of the schools in Nebraska qualified by these collective requirements (rural or town) and were included in the sample group for both this study as well as in the larger *CSI* study. The only restriction placed on participant eligibility was the population of the school identified by IES as a town was capped at 8,500. These figures and classifications were based on the 2010 census reports and IES classifications.

Significance

NCLB has driven heightened accountability standards for all schools to more fully educate every student to the greatest degree possible, not just at a local level, but at the international level as well. The institution of the public school system is attempting to respond to this call to action through enhancing the professional skills set of the existing teachers to meet with the changing demands in the context of organizational change. The professional development industry has become a multi-billion dollar a year industry as schools "race for the top." However, the revenue spent on traditional PD is not producing the desired translation to student achievement and, as such, is largely ineffective. Numerous additional support mechanisms are being proposed to encourage the transfer of new knowledge and skills to the distal learners, one of which is instructional coaching. While the research on instructional

coaching in science is relatively new, it has the potential to drastically alter the PD arena by successfully promoting desired student outcomes in meaningful and sustainable ways. Understanding the investment in and the limitation of coaching is relevant to professional development personnel as they attempt to augment teachers' knowledge, skills, and instructional strategies; to school and district level administrators as organizational change efforts are developed and implemented; and to state and federal agencies responding to increasing demands for cost effective solutions that improve student achievement.

Summary

Chapter One introduced the research focus to better understand how professional development programs have been traditionally provided, how this is inconsistent with the emerging framework of effective transfer to the classroom setting, and how instructional coaching is one of the mediums employed to bridge the gap between teacher professional development and student achievement.

Chapter Two will discuss the relevant research pertaining to what is known about professional development best practices with an emphasis being placed on the limited amount of research surrounding the utilization of instructional coaching support components. The specific research surrounding the various iterations of coaching roles will be introduced and clearly identifiable ingredients of successful professional development programs and active ingredients of successful coaching experiences are explored. Chapter Three presents research methodology used to inform the study including an extensive explanation of *CSI*: *Coaching Science Inquiry in Rural Schools*. This current study is situated in such a way as to examine specific aspects of coaching duration and teacher expectancy that are not part of the *CSI* research design. Chapter Four includes research findings, and the dissertation is concluded in

Chapter Five with the findings and the implications for future research.

Chapter Two

Literature Review

Decades of failed attempts to reform the public education system in the United States have shown that issues of accountability are far easier to identify than to solve. The two most recent presidential efforts to improve our nation's schools are President Bush's "No Child Left Behind" Act (NCLB) and President Obama's "Race to the Top" (RTTP) Program. Both of these efforts focus on increasing the accountability of schools in response to increasing public demand for a cost-effective solution to improvements in student achievement.

This literature review focuses on the best practices research on high-quality professional development and the emergence of coaching as a medium to support changes in instructional practices in the classroom. A variety of coaching models prevalent in the educational setting are identified along with the support roles that coaches assume in the typical coaching model. This chapter concludes with an overview of the very limited scholarly research connecting coaching support with increased student achievement.

Effective Professional Development

NCLB is requiring schools to change the way education is delivered at all levels of the public systems. Many schools lack access to the resources necessary to fully comply with the provision of the law, especially those schools in the most remote locations (Reeves, 2003). Highly skilled teachers are a cornerstone of NCLB with a large body of research supporting the connection between teachers skilled in both their content and strong pedagogical processes and student success (Darling-Hammond, 2000; Darling-Hammond & Berry, 2006; Wenglinsky, 2000). Improving teacher quality is supported by Titles I and II monies, but the needs are far greater than these resources. Consequently, about 30% of new teachers leave the

profession within five years, and these numbers are much higher for teachers who are unprepared or do not receive some sort of on-the-job mentoring (Darling-Hammond & Sykes, 2003). Benner (2000) estimated the cost of replacing these teachers to be between $8,000 and $48,000 each, depending on whether student learning costs are factored into the total. This cost has not likely gone down since the 2000 study and has the potential to amount to billions of dollars annually to replace teachers that might have been retained with adequate professional development support mechanisms in place.

The Center for Teaching Quality's research (as cited in Darling-Hammond & Berry, 2006) shows that school leadership and high-quality professional development have powerful impacts on both teacher retention and student achievement. Further, professional development is critical to ensuring that teachers keep current with changing content standards, methodologies, and new technologies for teaching and learning (Lawless & Pellegrino, 2007). The current body of literature on professional development links student achievement with effective professional development (Darling-Hammond, 2000; Wenglinsky, 2000). Extensive reviews of the literature have been conducted to consistently define what constitutes high-quality PD (Garet et al., 2001; Loucks-Horsley, Stiles, & Hewson, 1996). Lawless and Pellegrino state that "these studies [(Garet et al., 2001; Sparks, 2002)] have consistently indicated that high quality professional development activities are longer in duration, provide access to new technologies for teaching and learning, actively engage teachers in meaningful and relevant activities for their individual contexts, promote peer collaboration and community building, and have a clearly articulated and a common vision for student achievement" (p. 579). Ultimately, the most important factor in any high-quality professional development is effecting a change in not only how teachers view their teaching, but also in their understanding

of the content area in which they teach. Embedding teacher reflection on their own instructional practices can support this transformation. Research suggests that a team approach supports teachers' development of collective self-efficacy and ultimately a change in perceptions of both themselves and their students (Cantrell & Hughes, 2008; Lotter, Yow, & Peters, 2013).

One common tenet to effective professional development is that it requires much more than the traditional one-shot, sit-and-get workshop approach (Darling-Hammond & McLaughlin, 1995; Garet et al., 2001; Guskey & Sparks, 1991; Opfer & Pedder, 2011; Showers & Joyce, 1996). Cantrell and Hughes' (2008) study indicates that effective professional development must engage teachers in extended experiences that include self-reflection. It further suggests that the ongoing support of coaches and colleagues in collaboration promotes the teacher development processes. For the teachers, professional development involves change. Teachers benefit when these change processes are directly supported by, and closely related to, the context of the classroom where they can be put to immediate use. Denton, Swanson, and Mathes (2007) suggest that "there is evidence that professional development with characteristics typical of coaching or mentoring approaches is associated with better outcomes in terms of sustained impact on teacher practice" (p. 570; see also Garet et al., 2001). Coaching is an ongoing process that is job-embedded. Russo (2004) also notes in his study on school-based coaching that professional development must be ongoing. Without this ongoing professional development, few teachers will actually change their practices and schools will continue to see the same results they have seen before (Poglinco & Bach, 2004). In an effort to effect both teacher and organizational change, coaching has become a prominent feature in professional development efforts toward creating

the capacity for more highly qualified educators.

History and Types of Coaching

Joyce and Showers are well known leaders in development of coaching models dating back to the 1970s. Their work became especially important in January 2002 when No Child Left Behind (NCLB) legislation was enacted by Congress (Denton & Hasbrouck, 2009). The traditional one-shot professional development (formerly known as in-service) has often left teachers disenchanted and had little, if any, impact on student achievement (Guskey, 2000). Despite the enormous amounts of public monies being allocated annually to professional development, as few as 10% of teachers actually utilize the new information presented to alter their classroom instruction (Joyce & Showers, 1982).

One of the key pieces of NCLB was to create the Reading First Initiative (RF) while providing funding to help provide support for teachers to implement more effective reading instructional practices in their classrooms. In the legislation, the "use of coaches was suggested…as a viable way to provide sustained and effective professional development support to teachers" (Denton & Hasbrouck, 2009, p. 153). Further provisions of NCLB created thousands of reading coaching positions to support the initiative by mandating that each RF school be served by a reading coach (Denton & Hasbrouck, 2009). This influx of coaches into the schools was just the start of the next generation of professional development for teachers that involved a coaching component.

Professional development involving some sort of coaching model has been utilized in the business world for training new employees, updating current employees' skills, and improving the overall functional "bottom line" (Flaherty, 1999). Coaching has certainly existed in many areas such as athletics and industry, but has only recently emerged in

education (Hall, 2005). While the specifics of each of these areas are different, the ultimate goal of coaching is to improve the performance of the individuals being coached to a desired level through individuals that are skilled in their respective fields. To reflect the different approaches to coaching, many models of coaching have developed since the early 1980s (Lotter et al., 2013). Included in Lotter's models are executive coaching (Grant, Green, & Rynsaardt, 2010), collegial (peer coaching) coaching, cognitive coaching (Costa, Garmston, Ellison, & Hayes, 2002), team coaching (from business management fields), and reflective coaching (with its foundations in the psychological/counseling fields). Cornett and Knight (2009) identified the models that are predominantly utilized in educational settings to include peer coaching, cognitive coaching, literacy coaching, and instructional coaching. Many of these models have developed out of the models from business and industry, as well as athletics, and have been specifically tailored to meet the unique needs of the classroom teachers (Kowal & Steiner, 2007). Each coaching model has its own specialized approach and technique, but the underlying philosophy of providing high-quality, job-embedded, individualized, and sustained professional development remains constant. In a meta-analysis on professional development, Yoon, Duncan, Lee, Scarloss, and Shapley (2007) found that "a combination of in-service and follow-up support was an effective method of improving teacher practice and student achievement." Desimone (2009) indicates that research does not show an exact duration for professional development or support activities, but points out that an intense summer institute with follow-up should "include 20 hours or more of contact time" (p. 84). In a longitudinal analysis of 42 systemic change programs, Banilower, Heck, and Weiss (2007) found that sustained professional development for change may exceed 100 hours or more of contact time, but they did not indicate what amount was sufficient to elicit change.

One specific model of follow-up support that shows promise is a combination of in-service and coaching (Kretlow, Cooke, & Wood, 2012). With the demand for increased student achievement levels came the pressure to incorporate coaching components to teacher professional development experiences, although little empirical evidence is currently available to directly substantiate the effects of coaching on teachers and on the performance of their students (Denton & Hasbrouck, 2009; Feighan & Heeren, 2009; Neufeld & Roper, 2003; Russo, 2004). Marsh, McCombs, and Martorell (2010) noted that "the largest gap in the existing research on coaching programs is the lack of evidence of coaching programs' effects on student achievement" (p. 877).

Coaching Models

With the focus of this research on the impact of coaching as a support for translation of newly learned skills and practices into the classroom, the focus of the literature review on coaching models is limited to just those found most commonly in the school setting according to Cornett and Knight (2009). Despite the existence of other models of coaching in schools, Habegger and Hodanbosi (2011) suggest that the consensus for the best model is the instructional coach as it provides "ongoing training that addresses the issues teachers face daily in their classrooms and is aligned to state standards, curricula, and assessments" (p. 36), but it is important to have a general understanding of the other prevalent models currently being utilized in the schools. All of these models recognize the benefits that teachers gain through professional development experiences, but go beyond the traditional PD experience to actually practicing new strategies in the classroom where teacher engagement is critical to a fully effective professional development experience (Driscoll, 2008).

Peer Coaching

Peer coaching is one of the oldest forms of educational coaching that has its origins from the early 1980s. Swafford (1998) described the model as two teachers informally collaborating both in and out of the classroom on instruction, planning, and resource development. Typically, this model of coaching involves teachers within the same school providing mutual support for one another. From Joyce and Showers' (1982) findings, teacher involvement in workshops did not translate into changes in classroom practice. However, the addition of the support mechanism of peer coaching to the professional development resulted in an 80% gain in classroom implementation of new skills over the professional development alone. Follow-up studies found consistent results supporting the increases in classroom practices supported by peer coaching (Showers & Joyce, 1996). Additional findings from these studies indicated that key components of peer coaching included practicing new skills, mutual support, and discussion of data collections (e.g., classroom observations). This model relies heavily on the reciprocal relationships between teachers to provide mutual support toward effecting changes in classroom practices within a school.

Cognitive Coaching

Arthur Costa and Robert Garmston (2002) blended the perspectives of supervision models of those like Piaget with the motivational and therapeutic perspectives of Maslow and Rogers into what is known as cognitive coaching. The basic tenet of the model is that all humans are capable of change as they grow and develop cognitively in their lives. A skillful colleague (coach) is used to enhance the teachers' cognitive processes in ways to elicit the desired teacher and student outcomes. Cognitive coaching has become one of the most common forms of coaching used in schools today (Knight, 2006).

Knight cites Costa et al. (2002) in his book on Instructional Coaching (2006): "All behavior …is determined by a person's perceptions and … a change in perception and thought is a prerequisite to a change in behavior…human beings construct their own meaning through reflecting on experience and through dialogue with others" (p. 7). In Cognitive Coaching, the coach focuses the teacher on reflecting on their own thoughts, beliefs, and assumptions as the teacher moves toward self-reflection and regulation of their own behaviors. In short, the coach helps the teacher to develop the cognitive capacity to think (reflect) on their own practices and how effectively the desired outcomes are achieved through their practices (Costa et al., 2002).

Cognitive coaching consists of seven coaching methodologies to produce increases in student achievement and teacher self-efficacy, promoting higher order teacher reflection and provide for teacher support: modeling, explanation, coaching, scaffolding, reflection, articulation, and exploration (Dennen, 2004). The effects of cognitive coaching on teacher self-efficacy are clear, but the link to increased student achievement is mixed (2004).

Literacy Coaching

Literacy coaching emerged out of NCLB funding to increase literacy across the school districts and content areas through providing literacy-based instructional support (Shanklin, 2007). The literacy coach has a wide array of potential roles and content areas, from helping teachers with new reading strategies and providing support for student learning with tools like graphic organizers, to helping students to improve their writing skills (Knight, 2006). Due to the focus of the Reading First Initiative and NCLB, the literacy coach and the reading specialists of pre-coaching days have seemed to blend together. In many ways, the literacy coach's role is centered both on the teachers and on the students with the collective goal of improving such measureable outcomes as increased graduation rates are often addressed

through increasing students' literacy skills and fluency by improving reading and language skills.

The broad range of content and strategies utilized by the literacy coach, the methodologies from which they draw, and the multiple learning theories integrated into their practices leave their roles in schools much more broadly defined (Cornett & Knight, 2009). Literacy coaches are "most effective when they support the implementation and monitoring of research-based literacy interventions that classroom teachers can infuse into their instruction to develop students' vocabulary, fluency, and comprehension" (Taylor, Moxley, Chanter, & Boulware, 2007, p. 22). Much like peer coaching and cognitive coaching models, literacy coaching focuses on helping develop teacher skills. However, the student outcomes addressed cut across the content areas by addressing key student learning and organizational strategies and skills. Research conducted by Buly, Coskie, Robinson, and Egawa (2006) suggests that teachers are largely receptive to receiving support from literacy coaches.

Instructional Coaching

Instructional coaching developed in the early 1980s in response to the new ideas about how teachers learn (e.g., Joyce and Showers, 1982). As school districts recognized the need to help teachers meet the mandates for increases in student achievement (Neumerski, 2013), teacher support mechanisms shifted from one-time professional development to teachers learning in their classroom environment as they put new strategies into everyday instructional practices (Ball & Cohen, 1999). Influenced by cognitive learning theories, early coaching models were framed around peer experts co-constructing knowledge in a peer coaching arrangement (Neumerski, 2013). In practice, the limitations of peer coaching were realized when the peers were not equipped to support each other. Sailors and Shanklin (2010) describe

the need as "sustained class-based support from a qualified and knowledgeable individual who models research-based strategies and explores with the teacher how to increase these practices using the teacher's own students" (p. 1). Taylor (2008) emphasizes that the process was non-evaluative and individualized. The focus of the instructional coach is on curricula to improve instructional delivery.

Instructional coaching is "one form of instructional leadership…characterized by non-supervisory / non-evaluative individualized guidance and support that takes place directly within the instructional setting...intended to promote teachers' learning and application of instructional practice" (Taylor, 2008, p. 13). Only a few studies examine coaching (instructional coaching or other models) from the teachers' perspective (Neumerski, 2013), but it is clear that coaching has been linked to instructional change. "What is needed is more detail about how, why, and in what context these changes occurred" (Neumerski, 2013, p. 333).

Instructional coaching does not have a standard form for reference as its applications vary widely from classroom to classroom and building to building (Poglinco et al., 2003; Resnick, 2010). Instructional coaching roles vary largely because districts have unique resources, needs, and goals (Kowal & Steiner, 2007). The instructional coach is charged with marrying these factors with the teacher's specific ideas to help create a professional development plan to help the teacher attain their goals (Knight, 2006).

Summary of Coaching Models

The research on coaching is somewhat limited, but several trends have emerged in the research and practice in the last 20 years. In a meta-analysis of instructional coaching literature, The Education Alliance at Brown University found that instructional coaching

models tend to include "emphasis on professional collaboration, job-embedded professional development, and differentiated roles for teachers" (Borman, Feger, & Kawami, 2006, p. 2). The coaching models presently utilized in the public school systems match these items to varying degrees. Peer coaching relies heavily upon the expertise of one teacher supporting another teacher in the instructional improvement process. Cognitive coaching is centered on guiding teachers to actively reflect on their teaching practices and the degree to which these practices produce the desired student outcomes. Literacy coaches focus on the broadest range of instructional practices that impact overall student achievement including items like classroom management, content specific strategies, reading fluency, and formative assessment. The instructional coach "collaborates with teachers so they can choose and implement research-based interventions to help students learn more effectively" (Knight, 2006, p. 13). While each of these approaches has different models, methodologies, and practices, the ultimate goal of coaching is improving student achievement through improved teacher quality. With this goal in mind, it is important to understand what coaches actually do. Peters and Dew (2011) defined the roles of coaching to involve "listening, observing, questioning, and offering support to help practitioners grow, reflect and make intentional instructional decisions" (p. 175).

The Role of the Coach

Coaching has a history of being widely varied in both approach and methodology, which leads to the inconsistent definitions of coaching (Denton & Hasbrouck, 2009), in turn clouding the coaching literature. Several key elements and skills emerged from the literature that indicate the specific attributes of what constitutes a "good" coach. In an effort to better understand coaching, researchers have attempted to provide clarity to the coach's roles and

responsibilities. The general nature of these roles does not appear to be dependent on the specific model of coaching being discussed in the literature, but rather seems to transcend the models to some degree, although some items identified are clearly more closely linked to one model.

Regardless of the coaching methodology, coaching programs often involve similar characteristics and goals. As part of a school improvement study, Roelofs, Raemaekers, and Veenman (1991) identified five major coaching functions that teachers cited as making professional development more practical: provision of companionship, providing technical feedback, analysis of application, adaptation to students, and personal facilitation. In a synthesis of current research studies on the components of coaching, Knight (2006) proposed seven key principles: equality, choice, voice, dialogue, reflection, praxis, and reciprocity. Each study on coaching has a slightly different definition of the role of the coach, which presents great challenges in making meaningful comparisons between studies. Consequently, the next section will focus on key components of coaching which drawing heavily from Jim Knight's model of instructional coaching.

Active Ingredients of Coaching

Given the wide variety of coaching models and practices identified in the literature, this next section is to delineate those specific aspects of coaching that have been found effective, regardless of the specific coaching model being utilized.

Teacher–Coach Partnership

Effective instructional coaching requires a collegial relationship built around trust and mutual goals (Borman et al., 2006; Buly et al., 2006; Denton & Hasbrouck, 2009). The partnership developed between the teacher and the coach is essential to a valuable coaching

experience (Knight, 2006) and helping teachers translate research-based best practices into improved classroom instruction through effective communication (Borman et al., 2006). Knight's review of research encourages the development of the teacher–coach relationship prior to and during the coaching process (2004). These findings are consistent with Fullan's change theory (2006). These relationships are the foundations of trust between the teacher and the coach (Shanklin, 2007). Ertmer et al. (2003) reported that coaches believed their effectiveness with teachers was closely tied to their interpersonal skills. Specifically, key aspects of these relationships include the collegial (partner) and non-evaluative role of the coaches (Buly et al., 2006): a relationship in which the "coaches listen carefully and talk little" (p. 25).

Meeting Teacher Needs

Coaches must be able to meet the teacher's perceived needs (West & Staub, 2003) and provide help in diagnosing teachers' needs. Once the coach understands the teacher, support can be personalized to address these needs. Teachers are not always able to identify their needs, so the coach must be able to perceive the needs through classroom observation and intuition (Cantrell & Hughes, 2008). Flexibility is a key skill for the coach in building the teacher–coach relationship as the effective coach interprets the teacher's needs as well as the context of these needs, tailoring coaching support accordingly (Sugar, 2005). The sensitive nature of the teacher exposing their own needs or shortcomings highlights the required trust levels in the teacher–coach relationship and emphasizes the need for non-evaluative coaching.

Teacher–Coach Relationship

Knight stresses the value of coaching for not only struggling teachers, but for all teachers, in an effort to improve overall student achievement. "Coaching can move good

teachers to become great teachers. It provides the strongest return on the investment in teaching" (Knight, 2004, p. 21). In a study of instructional coaching effectiveness, Knight found a 70% increase in teacher implementation of new practices when supported by instructional coaching (2006). The value of effective coaching cannot be ignored, but the prospect of attaining such goals has a strong teacher–coach relationship as a cornerstone in the process (Costa et al., 2002; Ertmer et al., 2003; Feger, Woleck, & Hickman, 2004; Killion, 2007). The coach's ability to build positive relationships with staff members, especially those that are difficult, is key to success (Stock & Duncan, 2010).

Knight (2006) summarizes this relationship as being based with the terms equality, choice, and voice. The partnership based on trust illustrates the equal nature of the coach and teacher where the goals of coaching are codetermined by both the teacher and the coach. The collaborative nature of the process allows for both the teacher and coach to provide input into decision making, but the choice of what to learn or work to improve upon resides with the teacher. The individual perspectives of the teacher and coach are both valued, encouraging teachers to be "free to express their opinions about content being learned" (p. 25). Teachers who believe interactions with their coach will be used for professional evaluation purposes are less likely to utilize the coach's assistance (Killion, 2007).

Coaching Observations

Denton and Hasbrouck's (2009) found, through a "consensus" of the literature, that coaching includes some teacher observation, regardless of the model of coaching being used (e.g. Driscoll, 2008; Feighan & Heeren, 2009; Nidus & Sadder, 2011; Rose, 2009). From a meta-analysis of the literature conducted by Kretlow and Bartholomew (2010), a highly engaged, small group initial training followed by multiple observations, feedback, and

modeling is critical to coaching interventions. While their research did not specify a duration of the observations, other studies have identified the observation periods should be at least 30 minutes in length (Rivera, Burley, & Sass, 2004). However, the total duration of ongoing coaching support has yet to be explored as no specific statements regarding total amount of coaching needed to support translation of new skills and practices in the classroom settings have been found in subsequent literature reviews.

Classroom observations provide a shared experience for the coach and teacher to discuss and reflect upon. The follow-up to these observations of instruction is critical to evoking change in the teacher's practice and involve the coach utilizing strong knowledge of content, pedagogy, and curriculum to provide the basis for a meaningful dialogue (Brady, 2007; Feger et al., 2004). The coach artfully executes the practice of coaching by facilitating discussion of the observed instruction with the emphasis of encouraging reflection, both by the teacher and the coach (Feger et al., 2004). Coaches need to be:

> Open minded and respectful of other's views… [have] optimism and enthusiasm, confidence and decisiveness. They persevere and do not permit setbacks to derail [their efforts]…. They are flexible and willing to try a different approach if the first effort runs into roadblocks (Ingersoll, 2007).

This observational framework is consistent with Knight's principles of effective coaching (dialogue and reflection) while being embedded within the classroom setting (praxis). Collet noted coaches rarely adhere to a strictly linear model (2012). Instead, coaches are sensitive to the teacher's needs and modify their strategies to facilitate supportive discussion and reflection that push the teachers without overwhelming them.

While serving as a basis for discussion, the classroom observations provide evidence for the coach's analysis (Roelofs et al., 1991) and specific, meaningful feedback and encouragement (Cantrell & Hughes, 2008; Collet, 2012; Feighan & Heeren, 2009; Kretlow &

Bartholomew, 2010; Nidus & Sadder, 2011; Rose, 2009; Rudd, Lambert, Satterwhite, & Smith, 2009). Reflection on the observation further provides insight into teacher strengths and weaknesses for collaborating with the teacher for future targeted outcomes (Gallucci, Van Lare, Yoon, & Boatright, 2010). For the teacher, coach-encouraged self-reflection provides the necessary scaffolding toward independence from the coach as the teachers practice identifying their own strengths and areas for improvement (Collet, 2012; Feighan & Heeren, 2009; Powell, Diamond, Burchinal, & Koehler, 2010). While the coach can help facilitate the self-reflection by the teacher through purposeful questioning strategies, ultimately, it is up to the teacher to learn to regulate themselves—one of the goals of coaching. At the same time, the partner coach is learning from the teacher as the coach reflects on their own practices (Knight, 2006). This interplay of coach and teacher in a collaborative partnership of learning together is what Knight calls reciprocity.

Coaching Change Models

Collet (2012) examined the Gradual Increase in Responsibility (GIR) model of coaching for teacher change that was adapted from the Gradual Release of Responsibility model (Pearson & Gallagher, 1983). Similar to Knight's principles, "coaches model, make recommendations, ask probing questions, affirm teachers' appropriate decisions, and praise in order to provide decreasing scaffolding, which moves teachers toward interdependence and collaboration" (p. 1). The GIR shows a "curving line" from the largely coach dependent teacher to the more highly developed teacher that is less dependent on the coach. The "meandering" path is suggestive of both the non-linear way in which adult learners process information, but is also reminiscent of the cyclical nature of inquiry cycle. At the same time, the path reflects the ups and downs experienced by most teachers in the change process in

general. After the initial modeling phase (initial training), each subsequent stage is highly dependent upon effective coach–teacher communication. The teachers were providing reading (literacy) tutoring twice a week throughout a semester-long coaching intervention in Collet's (2012) study. Coaches recorded the frequency of their interactions with teachers they were coaching in the areas of modeling, recommending, questioning, affirming, and praising. During the first five weeks of coaching intervention, coach recommendations decreased steadily. As teachers developed confidence in implementing new strategies, coaches engaged in directed questioning to help scaffold the teacher to reflect on their experiences. This practice remained a consistent practice through most of the semester but did diminish as the semester progressed (bottoming out at eight to 10 weeks), suggesting the teacher was becoming more self-directed in directing their reflections. As teachers worked through the scaffolding, coaches provided more and more affirmation of teachers' instructional decisions until about week 8 of coaching, when the frequency of such interactions started to decline. As teachers started to demonstrate changes in their practices, praise became more prevalent in the coach–teacher interactions. While the dosage of praise started very low in this study, the frequency of coaches offering praise began to increase markedly from week 9 and beyond.

In summary, "the support that coaches provided changed in both quantity and quality" as the semester progressed (Collet, 2012, p. 38) and teachers gained both competency and confidence. The change in the teachers is shown as "meandering" as they experienced varied levels of successes and set-backs. Collet's data substantiates the "variable mediation provided by the coach as teachers' competencies were emerging and the coach leveraged teachers' abilities by providing…*progressive scaffolding*—support that changed to match teachers' increasing ability" (2012, p. 42). Collet's study examined teacher change in the context of a

university reading clinic which she admits has the potential to limit its application to broader contexts. As such, Collet suggests that the GIR model needs to be evaluated outside the clinical setting in the school setting. Although Collet did recognize the changes in teachers over time, she did not identify a point in the coaching process where teacher changes seemed to occur. Based on the frequency plots provided in her article, there appears to be a significant change in the role the coach assumed in the coaching process from about week 8 to week 10 (see Figure 2).

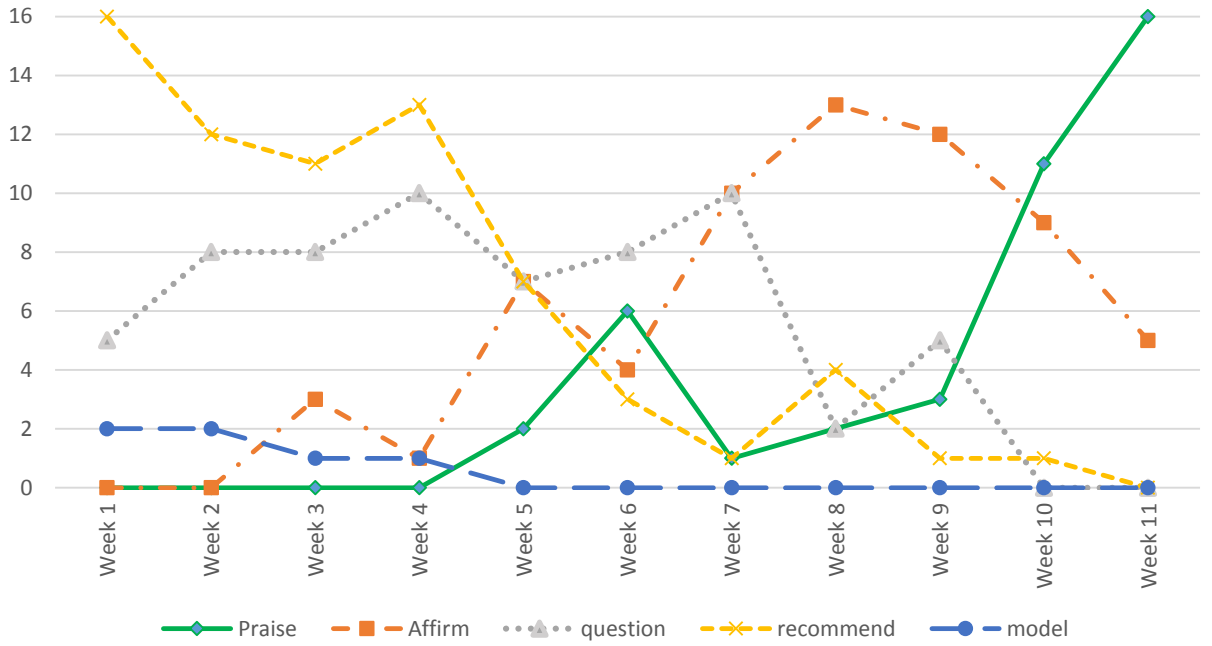

Figure 2. Changes in coaching practices over time (Collet, 2012)

Collet's research supports changes in the *coach's* role over time (GIR), but it does not include any specific mention of measured teacher skills during the coaching intervention, nor does it provide the necessary duration of coaching support required to elicit lasting changes in teacher practice nor changes in student achievement levels.

The findings of Lotter et al. (2013) further support the evolutionary process of

coaching in noting that teachers are better able to utilize coaches once they understand the coach's role. While the roles of the teacher and coach can be well defined, the development of this relationship takes time for trust to develop and to experience the process first-hand. Research has determined that it can take several months to develop the level of trust needed for an effective teacher–coach relationship (Ertmer et al., 2005). Despite clearly defined roles of the coach, the focus of coaching must be placed on engagement and adherence to these roles (McGatha, 2008). Lotter et al. (2013) found that teachers reported benefiting from the additional practice and engagement in the coaching process. Through coaching, teachers had opportunities to actively implement strategies collaboratively developed with their coach into their own classrooms (Feighan & Heeren, 2009; Rudd et al., 2009).

Coaching as a Part of Professional Development

Professional development (in-service training) has been used for decades to improve and change teacher instructional practices. The added follow-up feature of coaching as a mediating factor related to teacher change seems to be well documented in recent literature and continues to be a popular component of professional development experiences for teachers today. Coaching is not a stand-alone strategy but rather one that is an integral component of a greater professional development program (Driscoll, 2008). The ultimate goal of any professional development activities in the schools is to positively impact student achievement. To date, the link between coaching and student achievement has not been clearly identified like it has for the changes in teacher practice.

Coaching and Student Achievement

Although student achievement is not one of the items being addressed in this research, high-quality professional development activities focus on changing teacher practices that result

in desirable outcomes for the students. Understanding the connection between coaching support and student achievement is critical to assessing the costs and benefits of professional development efforts.

"In the context of education reform and efforts to raise student achievement, the development of effective teaching and teachers is…of central importance" (Allen, Pianta, Gregory, Mikami, & Lun, 2011, p. 1034), but identification of coaching professional development programs that produce reliable improvements in student achievement remain elusive with only two rigorous studies documenting "substantial impact" on student achievement. Both of these were limited to mathematics education.

Allen et al. (2011) conducted large-scale randomized controlled trial of a coaching program (My Teaching Partner-Secondary, or MTP-S) that included 78 secondary school teachers from 12 different schools over a 13-month period involving approximately 1,300 students. The study focused on enhancing secondary student motivation and achievement by coaching teachers on daily interactions with students. Teachers received an initial workshop-based training, a video reference library, and one year of instructional coaching support with a brief follow-up workshop. Teachers submitted video recordings of classroom instruction. Portions of the videos were selected by study-trained consultants (coach) for the teacher to reflect upon the segments and prompts that were generated by the consultant. This pre-coaching activity was followed by a 20- to 30-minute phone conference where the teacher and coach planned strategies to improve the student–teacher interactions. Coaching sessions happened about twice per month for the duration of one school year. While the focus of Allen et al.'s study was not on coaching duration, the amount of coaching contact time can be calculated to be approximately 40–50 hours over the course of the year using conservative

numbers of 10 months of twice-a-week phone conferences lasting 30 minutes each. However, this number does not reflect any coaching that took place outside of the phone conferencing timeframe.

Using the course Commonwealth of Virginia Standards of Learning (SOL) test for each course taught, student achievement was assessed. These assessments were given in both the intervention year and the post-intervention year and compared to students of teachers who received traditional professional development training without coaching support. "The effects of the intervention…at the end of the intervention year did not translate into statistically significant gains in student achievement until the post-intervention year" (Allen et al., 2011, p. 1036). The teachers did not receive any additional coaching support in the post-intervention year, but the change in the teachers' behavior remained and impacted the new set of students. In short, student achievement is not fully realized until the year after the coaching intervention has taken place. The study suggests that the lack of a student effect in the intervention year is representative of the difficulty in rapidly changing classrooms.

A study by Sanders and Rivers (1996) focused on the residual effects of teachers for student academic achievement in subsequent years. This study used the Tennessee Value-Added Assessment System as its basis for measuring student growth over multiple years. In evaluating nearly 3 million students' records for grades 2–8, it was noted that the effects of teachers on student achievement are both additive and cumulative in nature. Specifically, the study focused on student achievement as a function of the quality of the teachers they were assigned. Teacher quality had a significant impact on the level of student academic achievement. More specifically, "the residual effects of both very effective and ineffective teachers were measurable two years later, regardless of the effectiveness of teachers in later

grades" (Sanders & Rivers, 1996, p. 6). Although Sanders and Rivers made the point that administrators need to be cognizant of teacher assignments to facilitate growth in all students, the discovery that teacher effects were found in students' performance levels in subsequent years highlights the importance of improving teacher quality through effective professional development programs.

"Placing coaches in schools is a significant investment for which districts expect a return in terms of student achievement" (Killion, 2007, p. 12). Without additional research in the areas of coaching, it will be difficult for schools and policy makers to decide if such programs are worth the investment (Cornett & Knight, 2009; Neufeld & Roper, 2003). Evidence supporting student achievement to instructional coaching is beginning to emerge and the data are promising.

Coaching Duration

A pressing question for administrators and policy makers is how much and what types of professional development will produce improvements in student achievement. Professional development that is sustained over time promotes more in-depth discussions of content, student conceptions, and instructional strategies as well as more opportunities for teachers to practice new skills in their own classrooms (Garet et al., 2001). A summary of professional development literature reviews found that teacher PD should be "sustained" and "intensive" and is more effective in larger "doses" (Wayne et al., 2008, p. 470). Desimone et al. (2009) add that change in teachers, both intellectually and pedagogically, requires professional development to be of sufficient duration. "Research has not indicated an exact 'tipping point' for duration but shows support for activities that are spread over a semester (or intense summer institutes with follow-up during the semester) and include 20 hours or more of contact time"

(Desimone et al., 2009, p. 184). In a longitudinal analysis of 42 local reform efforts, Banilower et al. (2007, p. 392) "found impacts up to and beyond 100 h [hours] of professional development" but the study did not provide specifics on how much professional development was enough to promote change or what types were "enough" to improve student achievement (see also Lotter et al., 2011). Yoon et al.'s (2007) review of PD studies suggests a linkage between the duration of PD and its impact on teachers and students. Specifically, the professional development programs that were more intensive (ranging from 30 to more than 100 contact hours) produced significant effects on student achievement. As high-quality professional development has become integrated into the workplace of the teachers (Joyce & Showers, 2002), professional development efforts "typically require that a coach or mentor work with teachers…which is among the most expensive approaches to PD available. With what frequency, duration, and quality would coaching or mentoring need to occur to make a difference?" (Yoon et al., 2007, p. 470).

In general, "there is little evidence available about…the optimal amounts and duration" of coaching (Borman et al., 2006, p. 7). Anderson, Feldman, and Minstrell's (2014) study on science coaching reported a strong relationship between the amount of time the teacher and coach spend together and improvements in teacher practice. The study specifically quantifies the time to be "at least 10 hours for elementary teachers and 20 for secondary" teachers (p. 2). This is one of the few studies to attempt to identify a duration of coaching necessary to promote change, particularly in science teacher practice, but the stated values for duration of coaching support are uncorroborated in other high-quality research.

Further complicating the questions of coaching duration are the beliefs and prior PD experiences teachers being coached bring to the coaching process. These form the basis of the

teacher expectations. Not only does the teacher have to believe in the need for changing their behavior, but they also have to believe in their ability to perform the skills necessary to evoke the change (Bandura, 2010). More importantly, the teacher's belief in the coach and the coaching process as a mechanism to support teacher change potentially impacts teacher buy-in to new PD processes that may ultimately impact the duration of coaching support required.

Summary

The literature on what constitutes effective professional development is rich and broad in its content. Clearly, high-quality professional development programs have the potential to effect changes in teacher behavior and instructional practice. However, many times professional development remains as a simple sit-and-get model, without any sustainable efforts to facilitate true integration into effective teacher practices. To elicit greater transfer of new ideas and skills into the classrooms, coaching can serve as a medium of support.

The idea of coaching is not new, but its practice in the educational arena is becoming a common practice. While the idea of coaching comes from practices utilized in business and industry, K–12 education has only been using coaches for the last 20–30 years. Much of the history of that usage stems from literacy coaching. Four models of coaching are presently used in educational practices: peer coaching, cognitive coaching, literacy coaching, and instructional coaching. Each of these models has a slightly different focus and objective, but the overall goal is to improve individuals' performance. The role of the coach is as varied as the models, resulting in no one clear definition of what coaching is or how coaching "should" be done. Despite the lack of a unifying definition of coaching, several common themes emerged from the coaching literature. Many of these factors are based on the need for positive relationships developing between the teacher and their coach, allowing for true

individualization of the professional development experience as the teacher integrates the new ideas learned with their current classroom practices.

Regardless of the specific coaching model implemented, the coach supports the teacher as a follow-up to an effective professional development intervention. These interventions have been seen as a mechanism by which organizational change can be fostered. More specifically, the change efforts focus on the way teachers teach and learners learn. Unfortunately, the linkage from effective professional development to increases in student achievement is not as strong or causative as many in educational leadership had hoped. However, research to support coaching as an effective medium to ultimately support student achievement gains is beginning to emerge. In the age of increased accountability and high stakes testing, educational systems need to continue to develop new ways to increase the capacity of their teacher workforce and enhance the opportunities offered to their students. "But the costs of developing and delivering PD grows proportionally with the number of days involved, and requiring teachers to be out of the classroom on regular school days is disruptive to student learning" (Yoon et al., 2007, p. 470). The additional costs of instructional coaches to provide follow-up support integrating new strategies into instructional practice are inherently difficult to define in light of the highly variable definition, application, and focus that goes along with each model of coaching support. Given relatively fixed budgets, schools must have reliable research data to support decisions on allocating professional development funds. Specifically, when implementing a professional development plan that includes follow-up coaching support, the amount of coaching support and identifying which teachers are in the position to see more immediate success through coaching need to be better to understood for leadership to make informed decisions about investing in coaching programs. While the costs of ongoing

coaching support are not well defined, the costs of ineffective professional development are clear.

Chapter Three

Research Methods

Chapter Three will outline the research methods to be utilized in this study. As the new research was part of the existing research study, *CSI: Coaching Science Inquiry in Rural Schools*, a description of the existing research protocols for *CSI* is discussed. The discussion of the existing study is followed by a discussion of the new instrumentation added for this dissertation study as well as the planned analysis of the newly collected data.

Research Design

The purpose of this research was to better understand the relationship between classroom implementation of new instructional strategies, the duration of ongoing instructional coaching support, and teacher expectations as to the value of an instructional coach. It was hypothesized that the degree to which teachers are successful in transferring the knowledge and skills learned in structured professional development experiences was enhanced through ongoing follow-up coaching support. Ideally, financial and time resources would allow for each teacher to have the support for whatever timeframe was necessary to obtain the classroom integration, but the high stakes demands of NCLB and heightened awareness of return on investments by school patrons requires a more systematic approach. What amount of instructional coaching is optimal for supporting the translation of new strategies and skills acquired in professional development training to increased teacher performance? What is the relationship between the amount of time teachers are engaged in one-on-one coaching support and teacher performance? And what relationship exists between teachers' expectancy of the value of follow-up coaching support and the level of teacher performance? To better understand these questions and research approach, it is important to understand that the

context of this research was within the construct of a larger study: *Coaching Science Inquiry in Rural Schools (CSI)*. The next sections explains the *CSI* study to more fully see how this new research fit within the existing study and continues to page 51.

CSI: Coaching Science Inquiry in Rural Schools

The National Center for Research on Rural Education (R^2Ed) is housed in the Nebraska Center for Research on Children, Youth, Families and Schools (CYFS), in the College of Education and Human Sciences at the University of Nebraska-Lincoln. R^2Ed was funded by the Institute for Education Sciences (IES) at the U.S. Department of Education to conduct research for data-based understandings of what works, for whom, and under what conditions in the rural context, in the areas of instruction/education, professional development for teachers, and related issues (e.g., family–school partnerships).

One of many ongoing studies conducted as part of the National Center for Research on Rural Education was *CSI: Coaching Science Inquiry in Rural Schools*. *CSI* was a two-year, randomized controlled trial involving rural science teachers from Nebraska and Eastern Iowa. The primary research question of *CSI* was: What is the impact of professional development on guided scientific inquiry with follow-up coaching (treatment) versus no professional development (control) on (a) teacher inquiry knowledge, skills, self-efficacy, and beliefs and (b) student inquiry knowledge, skills, engagement and science attitudes? While CSI focused on the macro-level view of teacher professional development, this dissertation focuses on the more nuanced approaches of coaching duration and teacher expectancy.

CSI Participants

The *CSI* Professional Development targeted Nebraska State Standards for science inquiry, science inquiry instructional strategies, supports for classroom implementation, and

student engagement in science inquiry. The study involved 124 teachers at 109 unique schools and almost 4,000 student participants. The teacher participants were all secondary science teachers (grades 6–12) in either Nebraska or Iowa and taught in schools that were designated as either Town or Rural by IES. Science teacher participants represented the range of teaching experience from first-year teacher to 20+ year veteran teacher.

CSI Protocols

Each of the teachers assigned to the treatment group attended a two-week Summer Institute in which they learned the requisite skills to implement guided scientific inquiry into their classrooms as both a content and as an instructional practice. Teachers were provided with sample "unit" plans to implement in their classrooms and were encouraged to modify these plans to fit their students' needs and classroom settings. Teachers had the opportunity to practice a sample inquiry lesson and received immediate feedback from their peer teachers and instructional coaches during the Summer Institute. Each teacher was assigned to one of four instructional coaches with over 100 combined years of science teaching experience to provide support for the teachers that were asked to implement the new strategies into their classrooms the following school year.

Teachers were directed to video-record instructional periods in which they had implemented their inquiry lessons and submit these to their instructional coaches via Dropbox. Both the coach and the teacher reviewed the video utilizing Coach Protocol for Coaching Sessions (Appendix A) and the Teacher Protocol for Coaching Sessions (Appendix B) in preparation for the coaching session held after each inquiry lesson. Following a coaching protocol developed by the study that emphasized positive feedback, the teacher and coach met via WebEx to review and discussed the class period including what went well, what the

teacher would change, and what the teacher planned to do next to further develop the student understanding of the concepts being taught. This process continued throughout the implementation process until the "unit" lessons were completed and/or the teacher–coach pair jointly terminated the coaching support. Coaching sessions occurred approximately twice per week for the 6 to 8 weeks long implementation period.

CSI Instrumentation

The *Teacher Inquiry Rubric* (*TIR*; Nugent et al., 2012; Nugent et al., 2013) assesses teacher proficiency in guiding students to develop necessary science practices in: (1) questioning; (2) investigating; (3) collecting and recording data; (4) explaining; (5) communicating; and (6) applying science knowledge. Each of these categories was broken down into multiple specific, observable teacher behaviors that would classify the teacher's actions into one of four levels: (1) pre-inquiry; (2) developing inquiry; (3) proficient inquiry; and (4) exemplary inquiry. The overall goal of the *CSI* study was to support teacher development to the level (3) proficient inquiry level which corresponds with the tenets of guided inquiry instruction (Kunz, Nugent, Pedersen, DeChenne, & Houston, 2013). In addition to construct scores for each of the six categories, an overall score was given by the coach that represented a general impression of the teacher's overall performance for the instructional period.

The *Electronic Quality of Inquiry Protocol* (*EQUIP*; Marshall et al., 2009) is a rubric for assessing the quality of inquiry instruction. The rubric comprises 19 indicators in four main categories of instruction, curriculum, assessment, and discourse. Each indicator is rated on a 4-point scale: (1) pre-inquiry; (2) developing inquiry; (3) proficient inquiry; and (4) exemplary inquiry. The indicators range from the very specific micro-level factors of inquiry

instruction like time usage to the macro-level factors of curriculum. The descriptive rubric is "meant to provide a benchmark to challenge teachers…to improve the quality of inquiry-based instructional practice" (Marshall et al, 2009, p.49).

New Instrumentation

Two additional surveys were added to the *CSI: Coaching Science Inquiry in Rural Schools* study for this research. One survey (Teacher Expectancy Survey) measured teachers' perceptions of the value (expectancy) of an instructional coach for successful implementation of science inquiry skills and instructional strategies learned during the summer professional development experience into their classroom practice. The second new survey measured the teachers' confidence in being able to implement key behaviors in the classroom to elicit the desired student outcomes. Both of these instruments were variations of what Bandura has termed expectancy and beliefs.

Coaching Expectancy Survey

The researcher developed Coaching Expectancy Survey (Appendix E) was given to teachers prior to the professional development experience to assess the teachers' overall expectancy of the usefulness of the PD and coaching combination. This instrument consisted of 14 Likert-style items scored from 1 (Strongly Disagree) to 7 (Strongly Agree) that represented the teachers' perception of the value of an instructional coach. Items included on the Coaching Expectancy survey focused both on the direct implementation of new instructional practices into the classroom ("Working with an instructional coach will help me implement inquiry strategies into my classroom") and with the overall expected value of coaching support ("Coaching is a valuable part of the professional development process").

Teacher Confidence Survey

After each coaching session teachers completed the Teacher Confidence Survey (Appendix F), a 15-item survey to indicate teacher confidence to perform items identified as essential elements of the inquiry process. These items were drawn from the Teacher Inquiry Rubric (*TIR*) indicators that the researcher determined to be key elements in achieving exemplary ratings such as "I am confident that I can guide students to formulate testable questions" and "I am confident that I can guide students to effectively defend their findings to appropriate audiences." The Likert-style items are scored from 1 (Strongly Disagree) to 7 (Strongly Agree). The purpose of the first 14 questions was to provide a framework for the teachers to evaluate their own performance and to facilitate reflection on their present need for the instructional coach. The final question on the survey, "I am confident in my ability to implement inquiry instructional strategies in my classroom without additional coaching support," fully captures the teachers' confidence to proceed independent of the coach, but required the additional questions on the survey to provide a meaningful basis for teachers' to evaluate their performance.

Coaching Session Progress Summary

After each coaching session, the coach completed a corresponding 15-item Coaching Session Progress Summary (Appendix G) survey that includes the same content items as the Teacher Confidence Survey but worded from the perspective of the coach observer instead of the teacher. For example, for the teacher stem "I am confident that I can guide students to formulate testable questions" the coach survey read "The teacher effectively guides students to formulate testable questions." These Likert-style items were scored from 1 (Strongly Disagree) to 7 (Strongly Agree), but also include a 0 score for the items that were not observed

during the instructional period. This survey also included a yes/no question that asks the coach to determine if the teacher demonstrated any evidence of having watched their classroom video in preparation for the coaching session as well as a prompt to comment on any unusual circumstances impacting the lesson observed. These items were included to help identify and explain any outlier data in the analyses.

Institutional Review Board

Institutional Review Board: Permission was requested from the University of Nebraska-Lincoln Institutional Review Board (IRB) for expedited review as a change in protocol to the *CSI* study. The research protocols involved in this study met all three applicable criteria for expedited review. Specifically, the written surveys provide no more than minimal risk to the individual completing the surveys. Secondly, the information received from those being surveyed did not place them at risk for "criminal or civil liability or be damaging to their financial standing, employability, insurability, reputation, or be stigmatizing" (University of Nebraska-Lincoln, 2015). The names of those surveyed were translated to a teacher identification code and kept confidential throughout the research. The final criteria of expedited research were met and in alignment with this proposal since no aspect of this research was of a classified nature. Due to the unique time limits for collecting the necessary data from the *CSI* participant teachers, the Teacher Expectancy and Teacher Confidence surveys were reviewed and approved by the committee chair and subsequently submitted to IRB for approval as a change in protocol. An amended informed consent document was approved by IRB and signatures were obtained by participant teachers (Appendix H).

Bounding the Study

Population: The study population consists of 35 science teachers from 31 different school sites in Nebraska and western Iowa currently teaching science in a 6–12 grade classroom for the 2013–14 school year. Thirty-one of the teachers taught in public schools and four teachers taught in parochial schools. Thirty-three of the teachers were from Nebraska schools and two teachers were from Iowa schools. The experience level for population ranged from first year teacher through 20+ years' teaching experience. All of these teachers were assigned to the treatment condition for the 2013–14 school year in the larger *CSI* study.

Ethical Considerations: Due to the researcher's position as project manager for the *CSI* study as well as the direct supervisor of the instructional coaches, it was important that undue pressure not be placed on the teachers to participate in the study. When offering teachers the opportunity to participate, the researcher made it clear that these are two different studies and teachers were not required to participate in this study in order to receive financial incentives offered through the *CSI* study. No additional incentives were provided to the participant teachers for participation in this additional study.

Further, the nature of this study had the potential to appear evaluative in nature to the teachers and coaches. Consequently, special care was used to ensure no information about the responses to the surveys was shared during the coaching process.

Data Collection

Participant teachers completed a written version of the Coaching Expectancy Survey pre-professional development as part of the other *CSI* instrumentation. The remaining instrumentation was completed online utilizing web-based Qualtrics survey software. An

emailed hyperlink was provided to the teachers by their instructional coaches at the conclusion of each coaching session to complete the Teacher Confidence Surveys as well as one post-Coaching Expectancy Survey completed at the end of the coaching sessions. Similar hyperlinks were provided to the coaches to complete the Coaching Session Progress Summary measures after each session.

All additional *CSI* instrumentation was completed according to the existing protocols for the *CSI* study. Most of the instruments were completed online either via Qualtrics or customized database interfaces. Whenever feasible, new surveys were combined with *CSI* surveys to minimize the inconvenience to the participant teachers.

Data Analysis

Data scoring was completed when the instrument was converted to its electronic format by the Qualtrics web surveying software. Data input by respondents were validated while the survey was being completed, as responses to all items are required for submitting the survey. However, data input was not validated by any outside source. Participant responses to the surveys were downloaded from the web host into Excel files where each column corresponded with a specific item on the survey. Each teacher was assigned a teacher number for the *CSI* study, which are required fields in the surveys. The date the survey was completed was also captured by the web hosting system. The exported Excel files were used for descriptive statistical analysis and for importing data into SPSS Version 22 for Windows for more quantitative statistical analysis including correlational studies and determination of linear regression lines.

Cronbach's alpha was calculated for each individual instrument to confirm the internal consistency for Teacher Confidence Survey and the Coaching Session Progress surveys as

well as the Expectancy Survey. For each of the following research questions, teacher performance was measured collectively by the coach *TIR* rating, coder *TIR* rating, and coder *EQUIP* ratings of teacher inquiry instruction.

Analysis for Research Question #1

1. As perceived by the teachers and confirmed by the instructional coaches, what amount of instructional coaching was optimal for supporting the translation of new strategies and skills acquired in professional development training to increased teacher performance?

Survey responses for the Teacher Confidence Survey and the Coaching Session Progress Surveys have an item-wise match to each other. Correlations were calculated for the ratings of the teacher survey item "I am confident in my ability to implement inquiry instructional strategies in my classroom without additional coaching support" with the corresponding coach survey item "the teacher is prepared to effectively implement inquiry instructional strategies in their classroom without additional coaching support."

To see the confidence levels change over the coaching process, the mean values versus the coaching session number were generated. For the purposes of calculating means for the coaches, a score of zero (not observed) was treated as missing data as the opportunity to evaluate the skill(s) was not observed. The relative maximum of the teachers' confidence and the coaches' assessments indicated where the maximum benefit of ongoing coaching may have been realized.

Teacher Inquiry Rubrics (*TIR*) were completed by the coach after each coaching session and used to support the development of the inquiry skills indicated on the teacher and coach surveys. The *TIR* is one of the key documents used to drive the coaching process and

was the basis for each of the post-coaching confidence items. The coach scored each teacher's quality of implementation of the inquiry skills for each coaching session. However, the nature of the *TIR* (consisting of 31 indicators, six constructs, and one overall rating) generally requires evaluation over an entire inquiry cycle which typically takes more than a single class period to complete. As the entire inquiry cycle was frequently not observed (nor designed to be observed) in a single instructional period, not all of the categories could be scored for a given lesson. To capture the teachers' capacity to demonstrate skills in all the indicators of inquiry throughout the coaching process, ratings of the *TIR* were collected cumulatively by tracking the maximum performance level for any observed lesson. These maximum performance levels for all 31 *TIR* indicators were averaged for each lesson to generate a cumulative coach *TIR* rating for each teacher. The overall coach rated *TIR* score was used to indicate the quality of teacher implementation of the skills throughout the coaching process. This approach is a deviation from the original intent of the *TIR* but provides an assessment of teacher capacity to meet specific performance indicators in the classroom setting despite the limited scope of a single instructional session observation. The minimum level for proficiency was defined by *CSI* to be a level 3 and was used as a reference for teacher performance. An interpolation line was plotted for visual inspection. These lines were used to ascertain if ratings on the coach *TIR*, coder *TIR*, coder *EQUIP* ratings met or exceed the benchmark standard of at least a level 3 (proficient) and suggested that teachers had become proficient in implementing the skills necessary for inquiry instruction. Statistical correlations were calculated between the coach *TIR*, coder *TIR*, and coder *EQUIP* ratings for further validation of the coaches' teacher performance ratings.

Analysis for Research Question #2

2. What was the relationship between the amount of time teachers are engaged in one-on-one coaching support and teacher performance?

The duration of each coaching session was obtained from the WebEx recorded coaching sessions. The sum of the length of all the coaching sessions represented the total amount of time the coach and teacher spent in one-on-one coaching. For coaching sessions that were not recorded for any reason, the average length of the coaching sessions for that teacher were used in place of the missing time. Correlations were calculated between the total amount of time in coaching and final teacher performance scores. The coders provided an overall assessment of teacher performance by providing both the Final *TIR* and Final *EQUIP* ratings. The final teacher scores were a subjective impression by the coder on the level to which the teacher performs in general, taking into consideration all of the lessons observed. This value had the most subjectivity to it and also had limited variation as raters could only choose from the values 1, 2, 3, or 4 (from pre-inquiry to exemplary inquiry) for both the *TIR* and *EQUIP* instruments.

Analysis for Research Question #3

3. What relationship existed between teachers' expectancy of the value of follow-up coaching support and the level of teacher performance?

Correlations were examined to determine if a relationship existed between teachers' expectancy measured pre-professional development and the teacher performance as measured by the overall *TIR* and *EQUIP* ratings after receiving coaching support. Any strong correlations may have helped to serve as a potential predictor of teacher success with the coaching process that could have been used to determine which teachers were most likely to

have positive gains from coaching support.

Summary

This chapter reported the research methodology that was utilized in the study including a formalized description of the *CSI* study and many of its methodological and data collection procedures in addition to descriptions of the population, instrumentation, and data analysis. The next chapter focuses on the findings of the data collected and the results of the data analysis.

Chapter Four

This chapter presents the results of the data analysis as described in Chapter Three. The analyses are grouped by the primary research questions they addressed. Discussion of the findings can be found in Chapter Five.

Findings

Thirty-five science teachers representing 31 rural schools in Nebraska and Iowa attended the Summer Institute in June 2013 as part of the treatment condition for the larger *CSI* study's professional development process. Thirty-one (88.6%) of the teachers taught in a public school and four teachers (11.4%) taught in parochial schools. Three teachers (8.6%) withdrew from both studies and did not complete the implementation (coaching) phase of the studies (see Table 1). Thirty-two teachers implemented the inquiry skills and practices into their classroom during the following school year and received instructional coaching. This current study focused on these 32 teachers and the instructional coaching received.

Table 1

Participant Teacher Demographics

Characteristic (N = 35)	Number	Percent
School Type		
Public School	31	88.6
Parochial School	4	11.4
Gender		
Female	22	62.9
Male	13	37.1
Ethnicity		
White (non-Hispanic)	34	97.1
Asian Pacific Islander	1	2.9
Teaching Assignment		
Single Grade Level	8	22.9
Multiple Grade Levels	27	77.1
Advanced Degree		
Bachelor's Degree Only	16	45.7
Master's Degree	19	54.3

	Minimum	Maximum	Mean	SD
Teaching Experience (years)	1	36	15.9	8.6

Findings for Research Question #1

1. As perceived by the teachers and confirmed by the instructional coaches, what amount of instructional coaching was optimal for supporting the translation of new strategies and skills acquired in professional development training to increased teacher performance?

Teachers (n = 32) and coaches (n = 3) participated in 284 coaching sessions in the 2013–14 school year for teacher lessons taught between August 23, 2013 and April 9, 2014. The average teacher had 8.69 (SD = 2.070) coaching sessions with their instructional coach with the range of coaching sessions spanning from 5 to 16. After each coaching session, teachers completed the Teacher Confidence Survey and coaches completed the Coaching Session Progress Survey. Both surveys were rated on a 7-point (strongly disagree to strongly agree)

Likert scale and were measures of confidence. Scores for both the teacher and coach surveys were obtained from the item "I am confident in my ability to implement inquiry instructional strategies in my classroom without additional coaching support" and the corresponding coach survey item "the teacher is prepared to effectively implement inquiry instructional strategies in their classroom without additional coaching support." Coaching sessions were designed to focus on a single instructional period. In the event that multiple coaching sessions were held focusing on the same instructional period (frequently due to time limitations for the teacher), mean values of the ratings for the multiple sessions were used for analyses. Cronbach's alphas for the 15-item Teacher Confidence Survey and the 15-item Coaching Session Progress Survey were $\alpha = .94$ and $\alpha = .96$, respectively across all time points.

The next section is based on the teacher and coach perception of the teachers' ability to continue the coaching process without continued coaching support. To provide a more objective measurement of the level of teacher performance to support the perception that necessary skill levels were demonstrated by the teachers, independent coders (through *CSI*) provided ratings of teacher skills for each of the four video-recorded lesson as well as an overall rating for the teacher. The coded classroom videos included the first and last lessons of the inquiry unit and two lessons co-selected by the teacher and coach. Teacher–coach pairs discontinued the coaching process at time points ranging from the fifth coaching session to the 16^{th}. The variability of the total duration of coaching resulted in the distribution of data as seen below in Table 2.

Table 2

Coaching Sessions and Represented Teacher Numbers

Coaching Session	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Coach *N*	32	32	32	32	32	31	28	27	24	15	6	4	3	1	1	1
Coder *N*	31	3	10	10	18	9	11	8	11	8	1	2	0	0	0	0
% videos coded	97%	9%	31%	31%	56%	29%	39%	30%	46%	53%	17%	50%	**0%**	**0%**	**0%**	**0%**
% teachers coded	97%	9%	31%	31%	56%	28%	34%	25%	34%	25%	**3%**	**6%**	**0%**	**0%**	**0%**	**0%**

N = number of teachers; % coded = percentage of teacher videos available coded; % teachers coded = percentage of the 32 teachers observed at that coaching session

The small sample size and the uneven distribution of the video coding data limits the usefulness of some coaching time points for analysis. Specifically, the number of observations coded beyond coaching session 10 account for only 3–6% of the total sample (two teachers or fewer) at each individual time point. Consequently, these data points were eliminated from analysis of trend lines in Figure 3. Further, the number of teachers participating in a 10th coaching session dropped to 15 teachers from 24 teachers after the ninth session limiting the generalizability of data beyond the ninth session.

Additional follow-up exploratory analysis was done on the teacher and coach confidence levels at each session to determine if the difference between teacher and coach ratings was significant. Dependent t test results are shown for all coaching sessions overall all time points in Table 3. The results of these analyses were used for descriptive purposes, not for making any inferential evaluations.

Table 3

Teacher and Coach Confidence Ratings by Session

Session	Teacher Mean	Teacher *SD*	Coach Mean	Coach SD	Correlation	Corr. Sig.*	t	Sig.*	*N*
Overall	5.711	.9833	5.199	1.2663	**.487**	**.000****	**6.898**	**.000****	247
Session 1	5.212	1.2795	3.765	1.1801	**.546**	**.004****	**6.277**	**.000****	26
Session 2	5.087	1.0167	4.340	1.4428	.261	.163	**2.668**	**.012***	30
Session 3	5.378	1.0023	4.926	1.1001	.394	.063	1.870	.075	23
Session 4	5.534	.9309	5.176	.7841	.209	.276	1.781	.086	29
Session 5	5.793	.7723	5.241	.9876	.176	.360	**2.603**	**.015***	29
Session 6	5.972	.8031	5.517	1.0512	**.609**	**.000****	**2.884**	**.007****	29
Session 7	6.173	.8292	5.662	1.0629	**.399**	**.043***	**2.471**	**.021***	26
Session 8	6.205	.7426	6.000	.9381	**.500**	**.021***	1.094	.287	21
Session 9	6.289	.6975	6.137	.7470	**.466**	**.045***	.890	.385	19
Session 10	6.138	.7945	5.963	1.1439	.285	.494	1.220	.691	8

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Overall, there was a significant strong positive correlation (r = .487, p = .000) between the teacher and coach confidence ratings. The mean values of confidence for the teachers and coaches were compared over the coaching process (see Figure 3).

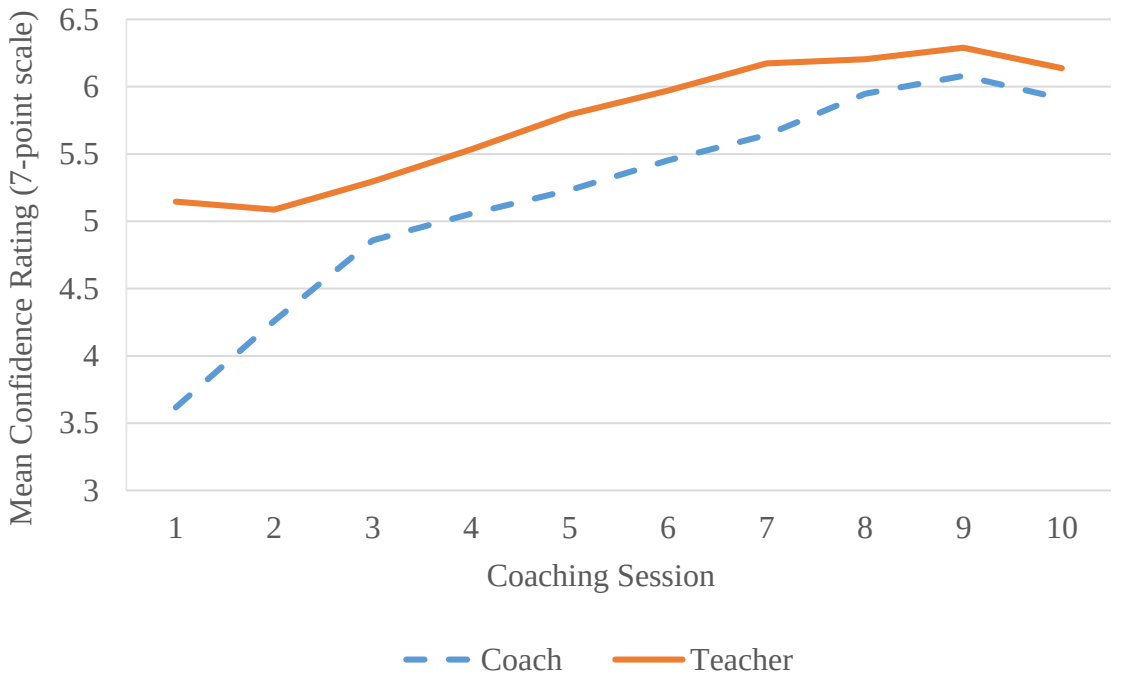

Figure 3. Mean confidence to implement inquiry instructional strategies without additional coaching support.

There was a significant difference in the teacher-rated confidence (M = 5.711, SD = .9833) and coach-rated confidence (M = 5.199, SD = 1.2663); t(246) = 6.898, p = .000 over the entire coaching process. The difference between teacher and coach ratings was either significant or approaching significant (sessions 3 and 4) until session 8 when these differences became non-significant. Data points beyond session 10 were excluded from analysis as only six teachers in the sample population had more than 10 coaching sessions. The trend lines for both the teacher and the coach suggest changes in the growth rates as coaching continued (see Figure 3). The trend line for the teachers levels off after session number 7. The trend line for the coaches continues the same overall trajectory from session 3 to a maximum level (6.080) being observed at session 9. However, statistical analysis of the significance of the observed changes in the trajectory of these lines is limited to descriptive statistics given the relatively small sample size, but t test results suggest that teacher and coach are observing the same level of performance from session 8 and 9. The issue of sample size is further noted as less than half of the teachers (n = 15) participated in the coaching process for at least 10 sessions, again limiting the generalizability of the data for the 10^{th} session.

Coaches rated each classroom video for observable teacher behavior that would classify the teacher's actions into one of four levels: (1) pre-inquiry; (2) developing inquiry; (3) proficient inquiry; and (4) exemplary inquiry. To get a single score representing the teachers' performance level on the *TIR*, scores were combined to form a cumulative *TIR* after each video that indicated the maximum performance level observed for the teacher, during any video observation, for each of the indicators. These indicators values were averaged to create a single coach *TIR* rating at each coaching session. Independent coders coded a *TIR* on each video to assess the inquiry instruction in the observed lesson. By coding the 4-level *EQUIP*,

the coders also completed the more macro level assessment of the quality of inquiry instruction for four main categories (instruction, curriculum, assessment, and discourse) on the same four levels of teacher performance as the *TIR* (pre-inquiry, developing inquiry, proficient inquiry, and exemplary inquiry). Overall coder *TIR* and coder *EQUIP* ratings for video were calculated utilizing the maximum performance levels observed outlined for the overall coach *TIR* rating. The mean values of teacher performance ratings were plotted versus the coaching session number in Figure 4.

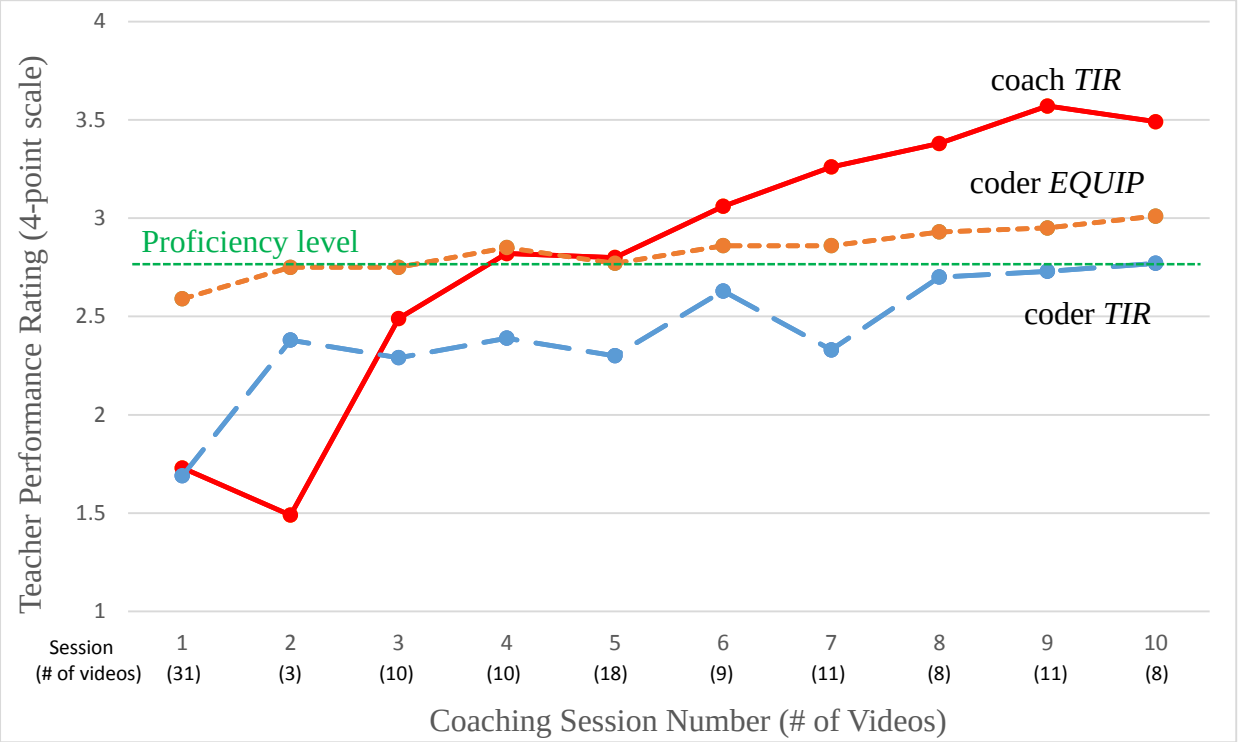

Figure 4. Teacher performance ratings by coaching session

Coach *TIR* scores indicate teacher performance at the start of coaching was in the pre-inquiry (level 1) and developing inquiry (level 2) levels. As the number of coaching sessions increased, coaches indicated increased teacher performance levels to proficient inquiry (level 3) and exemplary inquiry (level 4) with a maximum mean rating of 3.57 being recorded at

session 9.

Coder ratings of teacher performance followed a similar pattern to the coach-rated *TIR* scores showing increases in teacher performance as the number of coaching sessions increased. Coach and coder *TIR* ratings were very similar at session 1 with the coach-rated *TIR* scores exceeding the coder *TIR* scores for session 3 and beyond. Coder-rated *TIR* data reached a plateau at sessions 8 and 9 with an average value (2.72) below the proficiency level of 3. *TIR r*atings beyond session 9 are subject to sample size limitation (see Table 2). The coder *TIR* ratings show more variability across the coaching process as only four videos were coded for each individual teacher (as defined by *CSI* coding protocols). The first and last classroom observations were included in the coder scored *TIR*s, but the other two videos were spread out over the coaching timeframe for each teacher. Relatively small numbers of observations ($n < 4$) at some coaching time points resulted in data points that appear to be outliers (e.g., session 2) created by the sampling of classroom videos coded. Session 7 has a marked deviation from the data at both sessions 6 and 8 but is not due to limited sample size at that time point. This deviation from the trend is discussed in Chapter Five.

Coder ratings of the quality of inquiry instruction as scored on the macro-level focused *EQUIP* rubric showed the least amount of change from coaching session 1 to session 10. Average ratings of 2.59 (between developing proficiency and proficient levels) at session 1 to the highest scored level of 3.01 (proficient level) at session 10. Coaching sessions 8 and 9 do not have the sample size concerns associated with session 10 already noted. The average score for sessions 8 and 9 are just below the proficient level (2.94). This change in rating levels represents an upward movement of teacher performance to the targeted proficiency level. Correlations of teacher performance measures are shown in Table 4.

Table 4

Correlations of Teacher Performance Measures (Average of Maximum Values)

Variable	Mean	*SD*	Coach *TIR*	Coder *TIR*	Coder *EQUIP*
Coach *TIR* rating	2.69	.836	--	**.511 (.000)****	**.487 (.000)****
Coder *TIR* Rating	2.29	.628		--	**.681 (.000)****
Coder *EQUIP* Rating	2.79	.277			--

**. Correlation is significant at the 0.01 level (2-tailed)

Significant strong positive correlations were found between the coach and coder *TIR* (r = .511, p = .000), coach *TIR* and coder *EQUIP* (r = .487, p = .000), and coder *TIR* and coder *EQUIP* (r = .681, p = .000). All measures of teacher performance, regardless of the observer or instrument, showed a general trend toward increasing levels of performance during coaching. Variations from general trends were potentially a result of small total sample size. The ratings from all three sources increased over the coaching process with the greatest change observed in the coach-rated *TIR*. The least variation in rating values throughout coaching process was observed in the *EQUIP*. Coaches rated teachers' performance higher on the *TIR* with the proficiency level rating of 3 or better occurring between the fifth and sixth coaching session, but the coder ratings of *TIR* and *EQUIP* were not approaching the proficient levels until approximately coaching session numbers 8 or 9. Peaks in teacher confidence between sessions 8 and 9 coincide with coder *TIR* and *EQUIP* scores that are approaching the targeted level of proficiency.

Findings for Research Question #2

2. What was the relationship between the amount of time teachers are engaged in one-on-one coaching support and teacher performance?

The total amount of time teachers spent engaged in coaching was obtained from the recorded WebEx coaching sessions. Of the 269 unique coaching session recordings, seven teachers

experienced technical issues with a total of eight web-based coaching sessions. Duration for these coaching sessions conducted via alternative formats (e.g., via telephone) were estimated by computing an average coaching session duration and including this calculated value for the missing data. Teachers averaged just under 7 hours (*M* = 6:44, *SD* = 2:34) engaged in one-on-one instructional coaching. For the coaching process as a whole, overall assessments of the teachers' performance was evaluated by independent coders. The Final *TIR* scores were subjectively assigned by the coders as an overall evaluation of teacher performance across four lessons, using the overall lesson ratings for each as a reference. Final *EQUIP* ratings were determined using the same process as the Final *TIR* using the *EQUIP* rubric. Correlations between the total time engaged in coaching sessions compared to teacher performance ratings are shown in Table 5.

Table 5

Correlations of Total Time in Coaching Sessions with Final Teacher Performance Measures

Variable	Mean	*SD*	Total Coaching Time	Final *TIR*	Final *EQUIP*
Total Coaching Time	6:44	2:34	--	.142(.439)	.132(.471)
Final *TIR* Rating	3.56	.716		--	**.376(.034)***
Final *EQUIP* Rating	3.00	.359			--

*. Correlation is significant at the 0.05 level (2-tailed)

The correlations between the total amount of time spent working directly with an instructional coach and the final teacher performance ratings as measured by the Final *TIR* (r = .142, p = .439) and Final *EQUIP* (r = .132, p = .471) were both positive but not significant. While teachers improved in the demonstration of the inquiry skills over the coaching process, no significant relationship between the amount of one-to-one coaching time and changes in teacher performance levels was observed. A moderate positive correlation (r = .376, p = .034)

was observed between the Final *TIR* and Final *EQUIP* scores as expected as both instruments measure the multiple facets of inquiry instruction, although the *EQUIP* is a more broad assessment of the classroom than the *TIR*.

Findings for Research Question #3

3. What relationship existed between teachers' expectancy of the value of follow-up coaching support and the level of teacher performance?

Teacher expectancy of the value of follow-up coaching support was measured prior to starting professional development. Using 14 Likert-style items scored from 1 (Strongly Disagree) to 7 (Strongly Agree) on items like "Working with an instructional coach will help me implement inquiry strategies into my classroom" and "Coaching is valuable part of the professional development process," the degree to which teachers perceived the value of an instructional coaching support was measured. Correlations between expectancy and the coders' overall teacher performance ratings are shown in Table 6.

Table 6

Correlations between Expectancy and Teacher Performance Ratings

Variable	Mean	*SD*	Pre-PD Expectancy	Final *TIR*	Final *EQUIP*
Pre-PD Expectancy	6.34	.46	--	-.16 (.38)	.04 (.82)
Final *TIR* Rating	3.19	.78	--	--	**.48 (.006)****
Final *EQUIP* Rating	3.00	.36	--	--	--

**. Significant at the 0.01 level (2-tailed)

No significant correlations were found between the final teacher performance ratings and expectancy. Teachers' pre-professional development expectancy scores showed a weak negative and non-significant correlation (r = -.16, p = .38) to the Final *TIR* rating and a weak positive and non-significant correlation (r = .04, p = .82) to the Final *EQUIP* ratings. The

mean values of expectancy were very high (M = 6.34) and subject to ceiling effects.

Summary of Findings

The majority of teachers in this study participated in 10 or fewer coaching sessions. Teacher confidence trends upward over the coaching sessions, but the trend line (see Figure 3) suggests that there may be a plateau during the seventh and ninth coaching sessions. Coach confidence in the teachers' ability to practice inquiry instruction in the classroom had a steeper trajectory for sessions 1–3 followed by a more moderate trajectory for the rest of the coaching sessions. Beyond session 3, the trajectory of the teacher and coach lines were largely similar with the teacher consistently rating their confidence higher than the coach. At session 8 and beyond, the difference between the teacher- and coach-rated performance levels are not significant.

Teachers' performance levels were rated by both the coach (*TIR*) and independent coders (*TIR* and *EQUIP*). Coaches and coders had similar *TIR* ratings at session 1 with continued growth throughout the coaching process. However, as the number of sessions progressed, the difference between the coach and coder ratings became progressively larger. After session 2, the coach rated the teacher consistently higher than the independent coder with the highest rating occurring at the ninth session (see Figure 4). Coder scores for *EQUIP* changed the smallest amount throughout the coaching process with the difference of approximately .4 points on a 4-point scale between the first and 10th sessions. The more macroscopic assessment of teacher performance (*EQUIP*) was rated higher than the more microscopic assessment of teacher performance (*TIR*) throughout the observations recorded. Both the *TIR* and *EQUIP* scores reached a level approaching the targeted proficiency score of

3 at sessions 8–9, but *EQUIP* scores exceeded the coder *TIR* scores throughout the coaching process.

Teachers spent approximately 7 hours engaged in the coaching process with the number of sessions ranging from five to 16 sessions. The relationship between the amount of time spent in coaching sessions and teacher performance was non-significant in this sample. Teacher expectancy of the value of coaching support pre-professional development was also not found to be significantly related to overall teacher performance indicators of *TIR* and *EQUIP*.

Chapter 5

Conclusions and Discussion

This chapter reviews the purpose of the study and provides a brief overview of the methodologies and procedures used to collect data. Major research findings presented in Chapter 4 are summarized and a discussion of these results presented. Conclusions about the findings and recommendations for future research are also presented.

Review of Study Purpose

The purpose of this research was to better understand the relationship between classroom implementation of new instructional strategies, the duration of ongoing instructional coaching support, and teacher expectations as to the value of an instructional coach. The degree to which teachers were successful in transferring the knowledge and skills learned in structured professional development experiences was enhanced through the ongoing follow-up coaching support. Ideally, financial and time resources would allow for each teacher to have the support for whatever timeframe necessary to obtain successful classroom integration, but the high stakes demands of NCLB and heightened awareness of return on investments by school patrons require a more systematic approach. What amount of instructional coaching was optimal for supporting the translation of new strategies and skills acquired in professional development training to increased teacher performance? What was the relationship between the amount of time teachers are engaged in one-on-one coaching support and teacher performance? And what relationship existed between teachers' expectancy of the value of follow-up coaching support and the level of teacher performance? These issues were studied in the context of a larger study, *Coaching Science Inquiry in Rural Schools (CSI).*

Review of Methodology and Procedures

Participants in this new study were the treatment group of the larger CSI study that targeted Nebraska State Standards for science inquiry, science inquiry instructional strategies, supports for classroom implementation, and student engagement in science inquiry. The teacher participants were all secondary science teachers (grades 6–12) in either Nebraska or Iowa and taught in schools that were designated as either Town or Rural by IES.

Each teacher attended a two-week Summer Institute in which they learned the requisite skills to implement guided scientific inquiry into their classrooms as both a content and as an instructional practice. Teachers were provided with sample "unit" plans to implement in their classrooms and were encouraged to modify these plans to fit their students' needs and classroom settings. Additionally, each teacher was assigned an instructional coach that provided support during the implementation of the inquiry science unit.

Teachers video-recorded their classroom instruction which was submitted to their coach. Distance-based, asynchronous coaching support was delivered to teachers via web-based conferencing applications (WebEx). *CSI*-developed protocols provided structure for both the teachers and coaches in preparing for and conducting the actual coaching sessions. The coaching sessions emphasized positive feedback and were largely driven by a *CSI*-developed inquiry skills instrument called the *Teacher Inquiry Rubric* (*TIR*). Teachers and coaches approached the coaching process with a partnership approach and jointly determined when coaching support was discontinued. *CSI* guidelines suggested that coaching sessions be held approximately one to two times per week over a 6–8 week unit implementation period.

Two additional surveys were added to the *CSI: Coaching Science Inquiry in Rural Schools* study. One survey (*Teacher Expectancy Survey*) measured teachers' perceptions of

the value (expectancy) of an instructional coach for successful implementation of science inquiry skills and instructional strategies learned during the summer professional development experience into their classroom practice. Teacher expectancy was measured prior to the professional development experience. Items included on the Coaching Expectancy survey focused both on the direct implementation of new instructional practices into the classroom with items such as "Working with an instructional coach will help me implement inquiry strategies into my classroom" and with the overall expected value of coaching support with items like "Coaching is a valuable part of the professional development process." The second new survey measured the teachers' confidence in being able to implement key behaviors in the classroom to elicit the desired student outcomes. This survey was completed after each coaching session. These items were drawn from the *Teacher Inquiry Rubric* (*TIR*) indicators that the researcher determined to be key elements in achieving exemplary ratings such as "I am confident that I can guide students to formulate testable questions" and "I am confident in my ability to implement inquiry instructional strategies in my classroom without additional coaching support." The specific items selected were not intended to be the most important elements of inquiry but rather to serve as to help the teacher establish some basis for determining their own confidence levels. Coaches completed a companion survey (*Coaching Session Progress Summary*) that includes the same content items as the Teacher Confidence Survey but worded from the perspective of the coach observer instead of the teacher. For example, for the teacher stem "I am confident that I can guide students to formulate testable questions," the coach survey read "The teacher effectively guides students to formulate testable questions." After each coaching session, the instructional coaches rated the teachers' skills level on the *TIR*. Teachers completed Coaching Expectancy Surveys in paper and pencil

format during the *CSI* Summer Institute. All additional surveys were completed via web-based survey software (Qualtrics).

As part of the *CSI* study, independent, *CSI*-trained coders scored teachers' classroom videos for both the *Teacher Inquiry Rubric* (*TIR*) and *Electronic Quality of Inquiry Protocol* (*EQUIP*). The *TIR* provided a more granular look at teachers' skills in inquiry instruction and *EQUIP* had a broader, more macro-level assessment of inquiry instructional practices. Teacher performance was measured by the coach *TIR* rating, coder *TIR* rating, and coder *EQUIP* ratings of teacher inquiry instruction.

Summary of Findings

This section will address the findings for the specific research questions along with a discussion of the results.

Research Question #1

1. As perceived by the teachers and confirmed by the instructional coaches, what amount of instructional coaching was optimal for supporting the translation of new strategies and skills acquired in professional development training to increased teacher performance?

For this group of teachers, the teacher and coach confidence levels triangulated with the coder *TIR* and *EQUIP* ratings suggest that teacher performance levels were optimized between the eighth and ninth coaching sessions. At this point in time, the teachers self-reported a relatively high confidence in their ability to continue the inquiry instructional skills and practices learned in the summer institute without the ongoing support of the instructional coaches. The instructional coaches' ratings of their confidence in the teachers' abilities to be successful without ongoing coaching was very similar to that of the teacher values, and at a level near the

top of the confidence scales. Although session 8 is the first time when both teacher and coach assessments of confidence are not statistically different, it was important that teachers had a solid grasp of the approaches they were integrating into their classrooms and the additional coaching session (session 9) provided the opportunity to reinforce and further bolster the teachers' confidence while the coaching support was still in place. For the rural science teachers in this study, the small populations and geographical isolation of many rural schools and districts greatly affects access to resources, thereby affecting a school district's ability to build the capacity necessary to comply with NCLB (Reeves, 2003). Many rural schools have difficulty in recruiting and retaining teachers, especially those in high needs areas. Research shows that such factors as school leadership and teacher empowerment have a powerful effect on both increasing student achievement and improving teacher retention (Darling-Hammond & Berry, 2006). Consequently, providing the additional support of the ninth coaching session seems to be one that is both logical and fiscally responsible given the great investment in both financial and human capital required to get to this point in the teachers' development. The inclusion of an additional coaching session is also consistent with good instructional practices that support student development while building confidence through progressively more independent practice.

Limitations of sample size precluded testing the small variations in the respective time intervals for significance. Even smaller sample sizes beyond session 9 limits the generalizability of the data beyond that session and group of teachers. Given these limitations in the data, the ideal number of coaching sessions for this group of teachers was between eight and nine sessions. No significant correlations were observed between the amounts of time teachers spent in one-on-one interactions with the coaches and teacher performance indicators

of Final *TIR* and Final *EQUIP*.

The process of having teachers reflect on their instructional practices was noted in previous research as supporting the transformations on new skills and strategies into the teachers' classrooms (Cantrell & Hughes, 2008; Lotter, Yow, & Peters, 2013). Cantrell and Hughes (2008) further noted that to be an effective element of change, self-reflection on teachers' abilities is essential. The *CSI* coaching model was designed to support teachers' development of self-reflective skills to assess their own teaching practices. While not every teacher fully met this objective, many made great progress toward changing the ways in which they observed their own teaching. However, the specifics of how much time such a change process would take in terms of teacher engagement in the process was still largely undefined in previous research.

Denton, Swanson, and Mathes (2007) suggested that "there is evidence that professional development with characteristics typical of coaching or mentoring approaches is associated with better outcomes in terms of sustained impact on teacher practice" (p. 540). Joyce and Showers (1982) suggested that as few as 10% of teachers actually utilize new ideas acquired in professional development experiences in their classroom instruction. Knight's research states this percentage will increase to nearly 70% of teachers implementing new practices when supported by instructional coaching (2006). Teacher growth over the coaching duration was noted in the teacher and coach assessments of confidence as well as the assessments of classroom skill demonstration as seen in Chapter 4. Triangulating the 8–9 coaching session timeframe with the coder-rated *TIR* and *EQUIP* scores highlighted these changes as being meaningful.

Coach-rated *TIR* scores for the teachers showed growth from session 1 through session 10, but the coach consistently overrated the teachers' performance on the *TIR* compared to the independent coders. A number of potential issues exist with using the coach as the ultimate coder for teacher performance. The close teacher–coach relationship and the joint planning of the instructional period processes highlighted by many previous research studies (see Knight, 2006; Borman et al., 2006; Buly et al., 2006; Denton & Hasbrouck, 2009; West & Staub, 2003; and others) may have resulted in the coach being more disposed to rate the teacher higher than the independent coders. It is important that these issues be explored more fully to understand the dynamics of the coach–teacher interactions that limit the objectivity of the coaches in the assessment of teacher skills demonstration. Understanding the coach–teacher relationship may allow for coaching professional development, enabling coaches to be more consistently reliable in measuring teacher progress during coaching.

Another possible explanation for coach–coder differences in assessing teacher performance is the limited science background of the coders. The coders were not required to have a formal background in either science or science education so the potential for coders to miss the more nuanced instructional strategies may have resulted in lower coder ratings. The degree to which the coach can provide an objective rating of their own coached teachers is an area that needs further investigation. The coders are assumed to provide the most conservative estimate to teacher performance levels on both the *TIR* and *EQUIP* rubrics and provided the best assessment for evaluating the impact of instructional coaching on performance in the classroom.

Coder-rated *TIR* had the most variability from session to session, but did show growth overall from session 1 to session 10. While the maximum ratings were observed at session 9,

there appeared to be only small gains from session 6 through 10 and one outlier point that is inconsistent with the trend line at session 7. Data points for coaching sessions 6, 7, and 8 consist of approximately the same number of participant teacher observations at each time point. However, the subset of teachers observed in sessions 6, 7, and 8 had very little overlap. Additionally, the qualitative differences in these groups of teachers may have contributed to the large variations from session 6 through 8. Numerous teachers with data included in session 7 were identified by their coaches as "struggling," either with the classroom in general or with new inquiry instructional approaches outlined by the *CSI* professional development process. In comparison, only two teachers observed in session 7 were also rated in session 6 or 8, and both were rated notably higher than the other teachers observed in session 7.

Coder-rated *EQUIP* scores were the most stable from session 1 through 10, with the maximum level observed at session 10. Given that session 10 was limited in its application to a broader population due to a small sample size, the very similar session 8 and 9 values were more easily substantiated. The relatively small overall changes of the *EQUIP* scores over the coaching process was most likely due to the more macroscopic nature of the *EQUIP* instrument. Given that instructional practices is a part of *EQUIP*, it is possible that the changes observed were a result of implementation of new inquiry instructional practices. Another contributing factor to this increase was that many of the coaches helped the teachers with overall instructional strategies that were not inquiry-specific like wait time after questioning. Many teachers received similar feedback on wait time during coaching sessions. Allowing students time to process and struggle with difficult concepts was an integral part of the inquiry strategies being implemented in the *CSI* study.

Triangulation of the confidence scores with the two teacher performance scores indicated that the teachers made significant improvements over the coaching process. Starting with session 8, the teacher and coach had no significant differences in their assessments of confidence in the teacher to perform without further coaching support. At the same point in coaching (session 8), coders rated the teachers' performance to have reached a plateau that was approaching the targeted level 3 (proficient). As each teacher entered into the coaching process with their own unique skill set and perceived needs, the coaching process was personalized and closely embedded with the classroom setting. Lotter et al. (2013) found that teachers reported benefitting from the additional practice and engagement in the coaching process; however, data in the current study suggest this effect may be limited as teacher gains did not continue to see measurable improvements in performance beyond session 9 despite some teachers continuing for up to 16 coaching sessions. Collet (2012) noted that coaches rarely adhered to a linear model, but were instead sensitive to the teachers' needs and abilities while pushing the teachers without overwhelming them. The Gradual Increase in Responsibility (GIR) developed by Collet further reflects the changes in teachers as being incremental with periodic setbacks over the change process. As teachers worked through the development process, the GIR model supports the changes in the teacher–coach interactions. Specifically, something happened with the relationship at week 8 of coaching where teachers started to demonstrate changes in their practices and the role of the coach became praise driven. Although Collet's study was a semester long and does not specify the duration of each individual coaching session (for direct contact time comparisons with the current study), the significance of the change point is still important. The change of the role of the coach to providing mostly praise (which was very low at the start of Collet's study) as opposed to other

more structured scaffolding approaches (very high at the start of Collet's study) is an example. In other words, teacher confidence had reached a level where they become more self-directed and no longer dependent on the coach to implement new instructional ideas. Collet's findings were further supported by Lotter et al.'s (2013) research supporting the evolutionary process of coaching where teachers were better able to utilize coaching support once they understand the coach's role. This same point was observed in the current study when the teachers self-rated their confidence levels to be sufficient to proceed without ongoing coaching support during the eighth or ninth session.

In summary, teachers in this study reached a high confidence level that was matched with a similar confidence level of their coach at session 8, and this level was maintained in session 9. Although the coaches rated the teachers' performance above the proficient level (a 3.0 or greater), independent coder ratings of teacher performance reached a level that was just below the proficiency level at that same eighth to ninth session. For the teachers observed in this study, the optimal number of coaching sessions was between eight and nine coaching sessions when the coaches followed the rigorous protocols delineated in the larger *CSI* study. The teachers demonstrated the integration of the new strategies and skills in their classrooms to a level that was rated to be nearing proficient. It is unclear if additional instructional coaching sessions or periodic follow-up coaching would have contributed to a greater transfer of science inquiry practices learned in the *CSI* Summer Institute into the classroom practice, but it is clear that at least 8 sessions were necessary for this group of teachers to demonstrate the inquiry skills identified on the *TIR* and *EQUIP* instruments. Teacher performance did improve in the 9th coaching session, but the gains were notably small. However, like many teachers in the rural localities, this group of rural science teachers has very limited access to

high-quality coaches or professional peers that could provide the meaningful, classroom embedded feedback that their instructional coach provided during the study. Consequently, the ninth coaching session supports pedagogically sound practices of supporting the learner (teacher) beyond the minimal levels to demonstrate proficiency. Further discussion of duration of coaching time is included in the next section.

Research Question #2

2. What was the relationship between the amount of time teachers are engaged in one-on-one coaching support and teacher performance?

Participant teachers had an average of about nine coaching sessions lasting 45 minutes each. Teachers and coaches had a similar changes in their confidence levels over the coaching process with the teachers consistently rating their confidence in themselves higher than the coach. The both teacher and coach confidence ratings approached the instruments ceiling scores. The difference between the teacher and coach ratings of confidence were not significantly different after the eighth coaching session. Further, the changes in ratings from coaching sessions 8 to 9 were not significant and were rated in the proficient range at approximately 3.5 on a 4-point scale. The confidence level for both the teacher and coach reached a maximum value at session 9, but there were only small changes in the teacher ratings from session 7 through 10. Coaches had a similar pattern of leveling off from sessions 8 through 10. These new findings are also consistent with research conducted by Yoon et al. (2007) supporting a combination of high-quality professional development with follow-up support (coaching) to change teacher practices. Desimone (2009) indicates that the research does not show an exact duration for professional development or support activities, but suggests that such activities should “include 20 hours or more of contact time” (p. 84).

Reviews of 42 systemic change programs (Banilower, Heck, & Weiss, 2007) pointed to teacher contact hours exceeding 100 hours, but they did not indicate the minimum amount sufficient to produce change. With an average teacher participating in approximately nine coaching sessions of 45 minutes in length, the total direct interaction time between the coach and the teacher in an individualized coaching forum is approximately 7 hours. Teachers in this study also participated in a two-week Summer Institute with an additional 6–7 hours dedicated to direct teacher–coach interactions in either one-on-one situations or as a small group of teachers led by the coach. Even conservative estimates of coach–teacher contact time in this study is less than 15 hours. In comparison, Allen et al.'s study coaching with teachers included direct contact time of nearly 40 hours over a school year with the bulk of this time attributed to coaching via phone conferencing. Desimone et al. (2009, p. 184) highlights that "research has not indicated and exact 'tipping-point' for duration but shows support for activities that are spread over a semester (or intense summer institutes with follow-up during the semester) and include 20 hours or more of contact time." A more recent study that focused on science teacher coaching quantifies the time needed to be "at least 10 hours for elementary and 20 for secondary" teachers (Anderson et al., 2014, p. 2). Anderson's study is perhaps the best comparison to the current study as it dealt with science teachers and changing instructional practice via coaching support. While Anderson does not delineate the exact breakdown of contact hours, the findings of the current study are consistent with Anderson's findings of less than 20 hours of contact time for the coaches with their teachers. In this group of teachers, the amount of coaching contact time had no significant relationship with overall teacher performance. This finding is consistent across the various levels of teacher preparation, experience, and skills found across the teaching population and further reflects the

varied amounts of time that learners take to understand new concepts. The myriad of skills and decision making processes involved in the practice of teaching serves to amplify these differences in amount of time needed to develop the requisite skills and confidence levels necessary to be an effective teacher. This result is supported by the teachers in this study ranging from five to 16 coaching sessions (approximately 11–18 contact hours) before coaching was voluntarily discontinued and many of the teachers either nearly meeting or exceeding the targeted proficiency levels. Although this group of teachers did not show a strong relationship between contact time and performance, a different group of teachers may show a greater correlative relationship. Further, understanding how teachers develop through the coaching process and how different subgroups (e.g., first-year teachers vs. more experienced teachers) of the teaching population change over time could be useful in predicting the duration of time coaching support will be needed. The impacts of other factors such as experience with prior professional development may also be useful as teachers develop expectations for the usefulness of professional development. Desmoines' (2009) findings noted the impact of intense summer institutes on changing teacher practice. Similar results are emerging in the larger *CSI* study as well, where significant gains were observed on both the *TIR* and *EQUIP* ratings for inquiry from baseline to post-professional development.

Additional limitations are noted in comparing coaching time with teacher performance using the *TIR* and *EQUIP* ratings. Measuring inquiry is a difficult task as the nuances of effective inquiry practices involved are difficult to capture in single lesson or single instrument. The *TIR* was never designed to be used as a stand-alone evaluation of a single lesson, but rather as an assessment across the inquiry cycle. Consequently, it is extremely difficult for a teacher to demonstrate skills in all 31 indicators in a single lesson. In fact,

teachers often did not demonstrate all 31 indicators across the four lessons coded. Additionally, coders were asked to rate individual teacher lessons based upon the indicators that were actually observed as it would be impossible to rate that which was not observed. The limitations of the *TIR* scores for evaluating overall final teacher performance became even more prominent as coders provided an overall rating of the teacher. Coders were instructed to subjectively assign ordinal values of 1–4 to rate the overall final teacher performance on the *TIR.* Consequently, the Final Teacher *TIR* scores have limited variability which limits the value of correlational studies.

The *EQUIP* is better suited for measuring inquiry in a single lesson; however, the range of lesson scores did not vary much between subsequent lesson observations. The macro-level nature of the *EQUIP'*s assessment of classroom inquiry did limit the ability capture smaller improvements in teacher practice with this instrument. The relative stability of the *EQUIP* across the coaching intervention simply did not discriminate between teachers, especially in the more subjective coder-assigned Final *EQUIP*. The scope of the *EQUIP* was much broader than the *TIR,* making the *EQUIP* less susceptible to indicators not being observed in a small number of lessons. In short, a granular level instrument of inquiry instruction for a single observational period does not presently exists and the number of high-quality instruments to measure inquiry in general is limited and worthy of future research.

Considering the number of potential factors influencing the number of coaching sessions and the total amount of contact time teachers required with a coach, the eight to nine coaching sessions benchmark should be considered a starting point for planning professional development programs with a follow-up coaching component. More time directly engaged with an instructional coach may produce greater results, but the return on the extra investment

for additional coaching time is not clear from the results of this study and merits further exploration.

In summary, this sample of teachers showed improvement over the coaching process, but the improvement was not directly correlated to the amount of time spent with the instructional coach. Each teacher–learner is different in the way in which they learn and their willingness to implement changes in their practice of teaching. Much like each student in the classroom takes a different amount of time to grasp a new concept, professional educators require different amounts of time to change their beliefs and subsequent classroom practices.

Research Question #3

3. What relationship existed between teachers' expectancy of the value of follow-up coaching support and the level of teacher performance?

Bandura's (1977) work has created a link between what a person believes and the role these beliefs play in retaining new patterns of behavior. Long-term change is developed by observing one's own actions rather than on performance feedback. The process of changing behavior is a two-part process that involves (1) the "person's estimate that a given behavior will lead to certain outcomes" (expectancy) and (2) the confidence or belief (self-efficacy) that one can complete the required behavior to achieve the desired outcomes (Bandura, 2010, p. 193). In short, the teacher must first believe that a particular change is needed *and* believe in their own ability to be able to make the necessary changes. In other words, expectancy is Bandura's terminology for what is commonly referred to as "buy-in." To rephrase Bandura, teacher buy-in to coaching was essential to the success of the coaching intervention to support their change processes. A pre-professional development assessment of teachers' expectancy as to the value of coaching was very high (6.34 on a 7-point scale), but not significantly

correlated to overall improvements in teacher classroom performance. The overall high rating of teacher expectations of coaching indicated that this group of teachers had a very high buy-in to the concept of coaching to promote the necessary changes in their classrooms. However, it is unclear that the expectancy instrument measured the teachers' belief that coaching was sufficient to promote the needed changes. Prior to the *CSI* study, many of the rural teachers involved had not worked with an instructional coach or with someone skilled in inquiry instructional practices. Although nearly all of the teacher participants in this group were familiar with coaching in general (many served as extra-curricular activity coaches in their schools and communities), but the concept of an instructional coach was relatively new to most of the participants. Many teachers noted that they had never had an instructional coach and appreciated having someone provide feedback from someone that "actually understood science" content and pedagogy. Additionally, the concept of what exactly constituted inquiry was largely misunderstood as evidenced by the large number of baseline videos provided to the larger *CSI* study that seem to equate inquiry with hands-on instruction. Collectively, the lack of experience with instructional coaching and the confusion as to what actually constitutes inquiry instruction may have contributed to pre-professional development expectancy scores not correlating to overall teacher performance. Perhaps the exceptionally high expectancy scores (probably too high) highlight the reality of geographic isolation and the limited resources available to the schools in the most remote locations of the states.

These observations may have been just a random effect, but identification of an instrument that could help to identify those teachers most likely to reap the benefits from instructional coaching may be useful. Through such an approach, limited resources for coaching support could be allocated to those most likely to make changes in their instructional

practice first. Of course, caution needs to be exercised when using such an approach. This practice may be useful in developing roll-out phases for intervention with the entire instructional staff. By establishing a core group of teachers that have adopted the desired instructional changes, the trained teachers can serve as mentors to other teachers in the district until all teachers can be trained. However, with this group of teachers, coaching expectancy did not provide any insight as to its potential value as a predictor of which teachers would be successful in coaching support.

Recommendations for Future Research

This study has indicated a starting point for planning the duration of ongoing follow-up coaching support for rural secondary science teachers in Nebraska following what was considered, a priori, to be a high-quality summer institute. These teachers generally improved their inquiry instructional skills and every teacher received job-embedded, individualized feedback from their instructional coaches that could be immediately implemented into their classrooms. Overall, these teachers showed a willingness to participate in the coaching process and utilize the feedback from the coaches in conjunction with their own reflections on their classroom performance to become more aware of the nuances of their own instructional practices. These reflective skills have the potential to build teachers' capacity to become more self-regulating, requiring less ongoing support to continue to implement the inquiry skills they had learned in the summer institutes. However, the applicability of these findings and the response to coaching support may not be generalizable to the greater teaching population.

Additional research needs to be conducted to determine if the protocols utilized in this study produce similar results in other, non-rural teacher populations in urban and suburban settings. Additionally, the procedures for conducting coaching sessions via distance-based

technologies needs to be further explored for application in the more urbanized settings. While great physical distances separated teachers, as well as teachers and coaches in this study, web-based coaching support has the potential to reduce the amount of time a coach may have to dedicate to traveling to the teachers in a more urban location. It is unclear if the web-based technology approach would be as well received outside the rural settings.

Beyond studying the delivery methods for coaching via distance-technologies, future research is needed to evaluate the value of instructional coaching beyond the targeted science teachers used in this study. Does web-based instructional coaching work for other content areas like mathematics, social studies, or languages? And, if the coaching does work for these content areas, can coaches legitimately be used across the curricular areas to support more than just a content-specific group of teachers? And how would the length of coaching support change between the various content areas? All of these are relative unknowns that would provide meaningful insight into the application of coaching support in teacher professional development.

Perhaps most important to the educational leaders that are considering developing and implementing a professional development program that involves follow-up coaching support is to truly understand the value-added component of coaching over the traditional professional development. In a large-scale, IES-funded study, the benefits of coaching beyond professional development alone were evaluated but showed limited additional value as provided through coaching for literacy (Garet et al., 2008). However, research on the added benefits of *science* coaching is limited at this point and is a topic that demands further investigation. For school leaders proposing organizational change through developing the capacity of the existing teaching staff, the return on investment analysis will prove invaluable. With schools being

asked to do more with less, the sustainability of such a coaching-based professional development plan is essential. With the costs associated with dedicated instructional coaches, peer coaching is emerging as potentially more sustainable option. One study of science peer coaching, *Coaching for Sustainability: Peer-Coaching Science Inquiry in Rural Schools* (Lee et al., 2014) suggests that teachers trained in the coaching processes are able to maintain the gains obtained by dedicated instructional coaches through follow-up peer coaching. How long such momentum can be sustained through peer coaching without a follow-up "professional" instructional coach has yet to be evaluated. The results of such a study would have broadly sweeping implications for the long-term applications of coaching as a viable option for schools.

Finally, all professional development in schools should ultimately have a positive impact on the achievement of all students in the districts. Current research indicates that students are showing improvement in their achievement levels in the year after teachers received coaching support (e.g., Allen et al., 2011). However, a longitudinal study that follows both teachers and students beyond the initial intervention year is needed to assess the value of coaching programs on student achievement. Such a study should address student impacts to provide insight into the benefits of coaching for not only the general educational student but also for providing meaningful gains in the achievement levels of mainstreamed students with special needs.

The value added to professional development through individualized instructional coaching as modeled in this study is associated with additional costs that are beyond the reach of many schools districts. But the social imperative to provide a high-quality education to our children must drive more creative funding priorities at the federal, state, and local levels. A

rich understanding of what works best for students is of little value if costs prohibit access for all but a small portion of the students in schools across the country.

Summary Discussion

As high-quality professional development has become integrated into the workplace of teachers (Joyce & Showers, 2002), professional development efforts "typically require that a coach or mentor work with teachers…which is among the most expensive approaches to PD available. With what frequency, duration, and quality would coaching or mentoring need to occur to make a difference?" (Yoon et al., 2007, p. 470). Understanding the frequency and duration of coaching necessary to support teachers in changing their instructional practices is imperative to assess the costs associated with staff development that includes a coaching component. While cost is not the only concern, it is among the most pressing of questions being faced by school leaders across the country as pressure for organizational changes promoting increased levels of student achievement on a limited budget. These changes cannot happen in isolation. In the age of increased accountability and high stakes testing, educational systems need to continue to develop new ways to increase the capacity of their teacher workforce and enhance the opportunities offered to their students. "But the costs of developing and delivering PD grows proportionally with the number of days involved, and requiring teachers to be out of their classroom on regular schools days" (Yoon et al., 2007, p. 470).

Some difficulty exists when attempting to quantify the costs for teachers in terms of dollars, but this is the reality facing many educational leaders as they attempt to do more with less, comply with the stringent guidelines of NCLB, and meet the challenges of President Obama's Race to the Top initiative. Teachers participating in this study taught science in rural

schools in Nebraska or western Iowa and are just a part of the thousands of rural teachers in this country charged with educating more than 12 million children in rural areas (Kena et al., 2014).

The following is an attempt to capture the actual costs associated with teacher participation in professional development with an ongoing coaching component. In Nebraska, the average teacher salary for 2012–13 school year was approximately $48,913 which, according to the National Center for Education Statistics (2013), is less than the U.S. average of $56,418. Assuming that the typical teaching contract in rural Nebraska is for approximately 185 days, the per diem salary costs for a teacher is approximately $264 (or approximately $33 per hour). The summer institute for *CSI* took eight days and was used to develop the concepts of inquiry, develop a coach–teacher rapport, and provide an opportunity for teachers to practice an inquiry lesson while receiving feedback from both their peers and their instructional coach. The 64 hours of summer institute time would cost approximately $2,112 per teacher for the teacher's time, with about $231 of that total being attributed to actual teacher–coach interaction time.

Teachers were asked to follow a pre- and post-coaching session protocol that included planning classroom instruction to practice newly learned skills, video-record the implementation, review their classroom video, upload their video to their coach, meet with their coach via WebEx (actual coaching session), reflect on their progress, and plan their next classroom observation. Overall, the *CSI* project estimated this process to take about 5 hours per classroom observation. Excluding the recording of the lesson implementation itself—it is already part of the teacher's contract time to do this part of the protocol—it takes the teacher approximately 4 hours of additional time prepare for, conduct, and reflect on a coaching

session. From this study, the average teacher participated in nine coaching sessions. At the hourly rate of $33 per hour, each coaching session has a "cost" of around $132 not including the actual lesson presentation itself. Therefore, approximately $1,188 is invested in additional coaching-related activities for the teacher. Considering the total time from summer institute, this total reaches $3,300 per teacher for the professional development plus ongoing coaching support. The results for this study suggest a coaching duration of eight to nine sessions with the total cost difference for the extra coaching session being about $132 for just the teacher. Considering the overall investment in improving instructional practices and building capacity to meet the demands of NCLB, the ninth coaching session is a small added cost.

Another way to consider the costs is to consider the cost of professional development alone ($2,112) with professional development plus follow-up coaching ($3,300). For just the teacher's contract time, coaching as designed by *CSI* adds about 56% to the cost of teacher improvement. This number does not include the costs associated with the coaches. This is one of the areas where the scalability of size becomes a major issue for rural schools.

The role of the coach in the school improvement process will have a major impact on how the costs of the coach will be distributed. One of the key issues identified in the literature review about the teacher–coach relationship is that it be positive and supportive, but not evaluative—administrative—in nature (Buly et al., 2006; Costa et al., 2002; Ertmer et al., 2003; Feger, Woleck, & Hickman, 2004; Killion, 2007; Taylor, 2008). In larger school districts in Nebraska, these positions may hold the title of director or coordinator, but these types of positions simply do not exist in the majority of rural school districts. While typically not in a purely administrative position, coaches are not in the same category as the faculty in the classroom, hence not on the same salary schedules, making the costs of the coach even

more difficult to project. Additionally, funding coaches as a single rural district is just not a possibility due to budgetary limitations.

Staffing costs are the largest costs for most educational organizations and the importance of continued professional development for teachers has never been greater. Compliance with the requirements of NCLB are challenging for many districts, but the challenges faced by rural schools are unique where limited access to resources is especially prominent (Reeves, 2003). Rural schools face exceptional difficulty in recruiting and retaining teachers, especially those in high needs areas. School leadership and teacher empowerment have a powerful effect on improving retention (Darling-Hammond & Berry, 2006). One of the keys to building the capacity of a district to comply with NCLB is to recruit high-quality teachers and continue to develop teachers through innovative professional development programs that show promise for improving teacher practice and student achievement. Today, that professional development needs to involve follow-up coaching as a component to lessen the isolation that rural teachers face every day.

With 87 percent of Nebraska school districts considered rural, the challenges have never been greater. Faced with high poverty, low student achievement, low teacher salaries, and unequal distribution of funds (Johnson et al., 2014; Johnson & Strange, 2007), rural Nebraska schools have to be creative in finding ways to overcome the disadvantages of the rural setting for education and create opportunities for job-embedded professional development. Extending the partnerships, or cooperatives, that already exist offers a potential to allow multiple schools to share the costs of professional development with coaching.

The practice of contracting professional services is not new to Nebraska schools. It has been practiced for decades for such needs as special education and school psychologist

support. Coaches could be funded in a similar fashion. The Educational Service Units (ESUs) can serve as additional facilitators and providers of coaching services as the need for the content-strong instructional coaches is great, but many smaller rural schools only have one or two dedicated science teachers in the district. However, the collective number of science teachers in the ESU member schools combined is great enough to warrant the cost of content-specific instructional coaches providing both a level of direct, non-evaluative support, while instantly creating a "community of practice" for science teachers required to be knowledgeable in all science areas in multiple grade levels (Lave & Wenger, 1991). Distance learning has proven to be an effective strategy for starting to address problems faced by rural schools in terms of providing teacher training. Teachers in the *CSI* study readily embraced the support from their coaches via web-based conferencing. The utilization of current and emerging conferencing technology is a logical next step to bridging the gap between the opportunities available to larger, more urban schools and those in the remote locations of the state. Research (Johnson & Strange, 2007, p. 12) has shown that approximately 85% of rural districts have used distance technology and shown "considerable satisfaction" with the experiences. Leveraging this experience to further develop and expand the offerings provided to promote rural schools is a logical next step as educators attempt to close the achievement gap across the state by building the capacity of teachers that work directly with students every day. This is the greater goal of school improvement demands heard since The Nation at Risk reports of the 1980s and currently echoed in NCLB legislation and the Race to the Top initiatives. The key players in facilitating these changes are the schools themselves, along with the state and local agencies that fund education. Leaders in every state have committed their administrations to the challenge of restructuring their school systems and the first step in achieving this goal is to

provide appropriate implementation strategies that involve research-based, best practices training to the educational professionals already in the field.

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Appendix A
Coaching Session Protocol – Coach's Form

Coach:		Teacher:	
Session Date :		Grade Level/Course:	
Lesson Date:		Lesson Number:	
Lesson Title:		Video Reference Number:	
Session Name:		Webex Meeting Number:	

Coaching Session Protocol - Coach's Form

☐  Start recording the WebEx session,  Record Start Time: _____

OVERVIEW AND INTRODUCTION (less than 5 minutes)

☐ Session Objective: Previous session student outcome(s) and teacher skill(s). (~ 30 seconds)
Student outcome: _____
Teacher skill: _____

☐ Provide positive feedback on lesson: (approximately 2-3 minutes) Begin with immediate positive feedback on what went well, focusing on how teacher behavior impacted student outcome(s):
_____
_____
_____

☐ Concept Taught _____
_____

☐ Have teacher share a their overall impression of the lesson; what went well, what could be improved, may also include a "Big Connection" aha moment (e.g., in which students made a connection between prior knowledge and the new concept or between the data and the explanation of the concept or misconception or teacher made a realization about teaching or content) _____
_____
_____

STUDENT INQUIRY SKILLS REVIEW (~5 minutes)

☐ Have teacher provide a **"Student Inquiry Skills Review"** based on the ***Inquiry Student Scoring Rubric*** for the class as a whole. (~30 seconds)
NOTE: Total for each row should equal 100%.

	% Beginning	% Progressing	% Proficient	% Exemplary
Identify Questions and Formulate Hypotheses				
Design and Conduct a Scientific Investigation				
Use Appropriate Tools and Techniques				
Use Evidence to Develop and Describe Relationships between Evidence and Explanation				
Communicate Procedures, Results, and Explanations of a Scientific Investigation				

Teacher comments regarding changes in skills percentages _____
_____

LESSON MODIFICATION AND ADHERENCE: (5-10 minutes)

- ☐ Teacher rating of lesson modification from CSI lessons. _____
- ☐ Coach rating of lesson modification from CSI lessons _____
- ☐ Description of modifications _____
  _____
- ☐ Teacher rating of adherence to their lesson plan _____
- ☐ Teacher sent separate lesson plan to coach to review (circle one) yes / no / n/a (100%CSI)
- ☐ Coach rating of adherence to teacher lesson plan_____ n/a (didn't send) n/a (100% CSI)
- ☐ Teacher description of deviations _____
  _____
- ☐ Coach shares where he/she saw deviations occur and how those deviations relate or not to student inquiry skills. _____
  _____

TEACHER INQUIRY SKILLS REVIEW AND CONNECTION TO STUDENT OUTCOMES
(30 minutes)
Check the appropriate boxes for each parts of the inquiry cycle that occurred during the class period that was recorded.

Identify Questions and Formulate Hypotheses	Design and conduct a scientific investigation	Use appropriate tools and techniques	Develop and describe relationships between evidence and explanation	Communicate procedures, results and explanations of a scientific investigation	Other: Please identify

- ☐ ***STRENGTHS***: _____
  _____
- ☐ Have teacher identify student outcome(s) that they observed in the lesson (from ***Student Inquiry Rubric***) followed with video clip(s) to illustrate strength(s) in teacher skill (could be from the ***Teacher-Coach Observation*** or from the ***Guidelines for Inquiry Instruction***; use ***Teacher Inquiry Rubric*** and ***EQUIP*** as resource) that supports student outcomes.
  1. **(required)** Video Clip start time stamp: _____
  Brief description of the video clip _____
  _____
- ☐ Coach identify and share student outcomes that they observed in the lesson (from ***Student Inquiry Rubric***) followed with video clip(s) to illustrate strength(s) in teacher skill (could be from the ***Teacher-Coach Observation*** or from the ***Guidelines for Inquiry Instruction***; use ***Teacher Inquiry Rubric*** and ***EQUIP*** as resource) that supports student outcomes.
  Strength(s) identified: _____
  _____
  1. **(required)**Video clip start time stamp: _____
  Brief Description of the video clip and strength: _____
  _____
  2. (optional) Video clip start time stamp: _____
  Brief Description of the video clip and strength: _____
  _____

Targeted Student Outcome(s): _____
_____

Teacher discusses implementation of and observations related to student outcome(s) selected: (Complete as part of self-reflection.)
_____
_____
_____

Coach shares observations related to student outcome(s):

Targeted teacher skill(s): _____

Teacher discusses observations related to implementation of skill(s)

Coach shares observations related to targeted teacher skill(s)

☐ ***SKILLS FOR IMPROVEMENT***: _____

☐ Have teacher identify student outcomes that they would like to improve (from the ***Student Inquiry Rubric***): _____

1. (optional) Video Clip start time stamp: _____
Brief Description of the video clip and skill: _____

☐ Coach identify a student outcome that you see as needing improvement (from the ***Student Inquiry Rubric***) followed by identification and discussion of area(s) for improvement in teacher skill (could be from the ***Teacher-Coach Observation*** or from the ***Guidelines for Inquiry Instruction***; use ***Teacher Inquiry Rubric*** and *EQUIP* as resource) that supports student outcomes. **Skills(s) for improvement**: _____

1. (optional) Video Clip start time stamp: _____
Brief Description of the video clip and skill: _____

☐ Joint Planning (using the Teacher-Coach Observation Form): During the coaching session, coach and teacher select Student outcomes and Teacher skills to be implemented in next lesson

☐ Teacher shares and coach joins discussion for Planning for Next Lesson: (Teacher comes with ideas)

1. What specific aspects of the inquiry process will I focus on in the next lesson? (introducing the lesson, data collection/exploration, using the data to develop the concept, applying the knowledge) _____
2. What is the concept that will be the focus of the lesson? _____
3. What is the main thing I want my students to learn or accomplish during this lesson (target student outcome / learning outcome)? _____
4. What evidence will I use to indicate that the students have learned / accomplished what I intended? _____

5. What prompts will I use to get the students to communicate their understanding / learning (oral &/or written)? _____
   _____
6. What will I do to help guide the students to the target outcome / learning objective? _____
   _____
7. How am I going to wrap up the next lesson? _____
   - _____

NEXT STEPS (~ 10 minutes)

1. Summarize and review positives: _____
   _____
   _____
2. Set or confirm next coaching session. Date _____ and time _____ for next coaching session.
3. Please record additional notes from this coaching session: _____
   _____
   _____
4. Record Stop Time: _____ Stop recoding; save the WebEx coaching session.
5. Name of Recorded WebEx coaching session file: _____

Session Reflection

Based on the video recording of the WebEx coaching session, what do you think were your strengths in this session?

Based on the video recording, what area(s) would you like to improve or practice before your next coaching session?

If I could change one thing about this coaching session, it would be...

What additional support do I need to make improvements in the next coaching session with this teacher? Or any teacher?

Appendix B
Coaching Session: Teacher's Form

1

Coaching Session: Teacher's Form

(*Please use to prepare for coaching session and during coaching session; open square = teacher completes PRIOR to coaching session; closed square = coach will discuss during coaching session*)

Session Date : _____ Session Start Time: _____

Lesson Date: _____ Lesson Title: _____

☐ **TEACHER completes prior to coaching session: watch classroom video and use as a guide**

1. What evidence do I have that the students learned / accomplished what I intended? _____
2. (If applicable) What evidence do I have that the students understood the concept? _____
3. What evidence do I have that students communicated (oral &/or written) their understanding / learning? _____
4. What were the students' responses to the wrap up for the lesson? _____
5. What did I do that was helpful in guiding the students to the concept (or other target outcome)? ____
6. Of the teaching strategies I used, what did I do well? _____
7. Of the teaching strategies I used, what would I like to improve? _____
8. If I taught this lesson again, what adjustments would I make? (e.g., order, materials, amount of time allocated for certain components, grouping) _____

COACHING SESSION OVERVIEW AND INTRODUCTION

- Coach's Introductory Comments: _____

☐ Teacher shares with the coach the **concept** that was the focus of the lesson: _____

☐ Teacher shares overall impression of the lesson: what went well, what could be improved, may also include a "Big Connection" aha moment (e.g., in which students made a connection between prior knowledge and the new concept or between the data and the explanation of the concept, or where teacher made a realization about either teaching or the content. **TEACHER: complete as part of preparation**

_____

_____

STUDENT INQUIRY SKILLS REVIEW

☐ Teacher provides a **"Student Inquiry Skills Review"** based on the ***Inquiry Student Scoring Rubric*** for the class as a whole. **(TEACHER: complete as part of preparation.)**

NOTE: Total for each row should equal 100%.

	% Beginning	% Progressing	% Proficient	% Exemplary
Identify Questions and Formulate Hypotheses				
Design and Conduct a Scientific Investigation				
Use Appropriate Tools and Techniques				
Use Evidence to Develop and Describe Relationships between Evidence and Explanation				
Communicate Procedures, Results, and Explanations of a Scientific Investigation				

☐ Teacher provides explanation/evidence for changes in student performance _____

_____

LESSON MODIFICATION AND ADHERENCE: TEACHER: complete as part of preparation

☐ Teacher perception of lesson modification from CSI lessons. Check one.

	No modifications	Less than 25%	25-49%	50-74%	75-95%	Almost everything modified (95-100%)
Teacher						

☐ Teacher perception of adherence to the teacher's lesson plan. Check one.

	No deviation (100% adherence)	76-99% adherence	50-75% adherence	26-49% adherence	Less than 25% adherence	Almost all deviation (0-5% adherence)
Teacher						

☐ Teacher shares modifications made to the CSI lesson and reason(s) for modifications. _____

_____

☐ Teacher states where the implementation differed from the lesson plan and why. _____

_____

TEACHER INQUIRY SKILLS REVIEW AND CONNECTION TO STUDENT OUTCOMES

☐ Check the appropriate boxes for each parts of the inquiry cycle that occurred during the class period that was recorded. **(TEACHER: complete as part of preparation.)**

Identify Questions and Formulate Hypotheses	Design and conduct a scientific investigation	Use appropriate tools and techniques	Develop and describe relationships between evidence and explanation	Communicate procedures, results and explanations of a scientific investigation	Other: Please identify

☐ ***STRENGTHS***: **(TEACHER: complete open square items as part of preparation.)**

☐ Teacher identifies student outcome(s) that he/she observed in the lesson (from ***Student Inquiry Rubric***) Followed by video clip(s) to illustrate strength(s) in teacher skill (could be from the ***Teacher-Coach Observation*** or from the ***Guidelines for Inquiry Instruction***; use ***Teacher Inquiry Rubric*** and ***EQUIP*** as resource) that supports student outcomes.
Strength(s) identified: _____
1. **(required)** Video Clip start time stamp: _____
Brief Description of the video clip and strength: _____
_____
2. (optional) Video Clip start time stamp: _____
Brief Description of the video clip and strength: _____
_____

- Coach's identified teacher strength(s) related to student outcomes:
Strength(s) identified:
_____
1. **(required)**Video clip start time stamp: _____
Brief Description of the video clip and strength: _____
_____
2. (optional) Video clip start time stamp: _____
Brief Description of the video clip and strength: _____
_____

☐ Targeted Student Outcome(s): _____

☐ Teacher discusses implementation of and observations related to student outcome(s) selected: **(TEACHER: complete as part of preparation.)** _____

_____
_____
_____
_____

- Coach shares observations related to student outcome(s):

_____
_____
_____
_____
_____

☐ Targeted teacher skill(s): _____
☐ Teacher discusses implementation and observation of targeted skill(s): **(TEACHER: complete as part of preparation.)**

_____
_____
_____

- Coach shares observations related to targeted teacher skill(s)

_____
_____
_____
_____

Additional observation related notes: _____
_____
_____
_____
_____

☐ ***SKILLS FOR IMPROVEMENT***: **(TEACHER: complete open square items as part of preparation.)**
☐ Teacher identifies student outcomes that he/she would like to improve (from the ***Student Inquiry Rubric***): _____

☐ Teacher identify and discuss area(s) for improvement in teacher skill (could be from the previous ***Teacher-Coach Observation*** or from the ***Guidelines for Inquiry Instruction***; use ***Teacher Inquiry Rubric*** and ***EQUIP*** as resource) that supports student outcomes.
Skill(s) for improvement: _____
1. (optional) Video Clip start time stamp: _____
Brief Description of the video clip and skill: _____
_____

- Coach's comments on identified skills for improvement that supports student outcomes:
_____
_____
_____

☐ **PREPARATION FOR NEXT LESSON: Teacher, please be prepared with ideas**

1. What specific aspects of the inquiry process will I focus on in the next lesson? (introducing the lesson, data collection/exploration, using the data to develop the concept, applying the knowledge) _____
2. What is the concept that will be the focus of the lesson? _____
3. What is the main thing I want my students to learn or accomplish during this lesson (target student outcome / learning outcome)? _____
4. What evidence will I use to indicate that the students have learned / accomplished what I intended? _____
5. What prompts will I use to get the students to communicate their understanding / learning (oral &/or written)? _____
6. What will I do to help guide the students to the target outcome / learning objective? _____
7. How am I going to wrap up the next lesson? _____
8. **Remember to email your lesson plan to your coach.** _____

REVIEW AND NEXT STEPS:

- Student outcome(s) selected for next lesson to be implemented:_____
- Teacher skill(s) selected for next lesson to be implemented: _____
- Coach's summary and review: _____
- Set or confirm next coaching session.
  Date _____and time _____
- Additional notes/follow up from this coaching session: _____

Appendix C
Teacher Inquiry Rubric

Teacher Inquiry Rubric

Skills Construct	Step in Inquiry Model	1. Pre Inquiry [Non-guided inquiry]	2. Developing Inquiry [Direct and Didactic; non-guided inquiry]	3. Proficient Inquiry [Guided Inquiry with Explicit/Didactic Teacher Guidance; low quality guided inquiry]	4. Exemplary Inquiry [Guided Inquiry with Scaffolded Teacher Guidance; high quality guided inquiry)
		No evidence of teacher instruction regarding:	Instruction addresses inquiry topic/construct through lecture or demonstration to help students **know/ recall/recognize** the skills. Teacher focuses on "what"	Teacher uses guiding questions, scaffolds, experiences, and/or feedback to help students **comprehend** the skills; underlying reasoning and processes. Teacher focuses on "how" and "why"	Teacher uses guiding questions, scaffolds, experiences, and/or feedback to help students **perform** the skills:
Question	Application	a) scientific questions b) questions that are testable c) questions that are specific d) scientific predictions or hypotheses that are based on scientific concepts e) predictions or hypotheses that are specific f) predictions or hypotheses that answer the identified question	Teacher **directly presents** or provides: a) scientific questions b) testable questions c) questions that are specific d) scientific predictions or hypotheses that are based on scientific concepts e) predictions or hypotheses that are specific f) predictions or hypotheses that answer the identified question	Teacher uses guiding questions, experiences, and/or feedback to help students **differentiate** between: a) scientific versus non-scientific questions b) testable questions versus non-testable questions c) questions that are specific versus general d) predictions or hypotheses that are based on scientific concepts versus those that are not based on scientific concepts e) predictions or hypotheses that are specific versus general f) predictions or hypotheses that answer the question versus those that do not	Teacher helps **students formulate**: a) scientific questions b) testable questions c) questions that are specific d) predictions or hypotheses that are based on scientific concepts [high school] e) predictions or hypotheses that are *specific* [high school] f) predictions or hypotheses that answer the question [high school]
Investigate [variables]	Exploration	a) variables for a scientific investigation b) independent and dependent variables in a scientific investigation c) control and manipulation of variables d) repeated trials	Teacher identifies, defines, and describes: a) variables in a scientific investigation b) independent and dependent variables in a scientific investigation c) control and manipulation of variables	Teacher guides students to: a) differentiate between relevant and extraneous variables in a scientific investigation b) differentiate between dependent and independent variables in a scientific investigation c) understand the need for and how to control and manipulate variables	Teacher helps students: a) specify/use relevant variables for their scientific investigation b) specify/use independent and dependent variables for their scientific investigation c) effectively control and manipulate variables [high school] d) conduct repeated trials within their investigation to validate results

		e) procedures to test the question f) procedures that are logical and sequential	d) repeated trials e) procedures to test the question f) procedures that are logical and sequential	d) understand the need for and how to conduct repeated trials e) differentiate between procedures that test the question and those that do not f) differentiate between procedures that are logical and sequential and those that are not	e) design and implement appropriate procedures that test the question f) design and implement procedures that are logical and sequential
Collect and Record Data	Exploration	a) selection and use of equipment b) collection of data that answers the question c) collection of data that is complete, accurate, and objective d) organization of data	Teacher directly presents or provides: a) equipment b) data collection procedures (with no connection to the need to collect data that answer the question) c) data collection procedures (with no explanation about criteria to collect data that is complete, accurate and objective) d) specifications for organizing data in graphs, tables, and/or charts	Teacher guides students to : a) differentiate between equipment which would be appropriate and equipment which would not b) differentiate between data collection procedures that answer the question and those that do not c) differentiate between data that is complete, accurate, and objective and that which is not d) organize data into graphs, tables, and/or charts	Teacher guides students: a) select and use equipment appropriate to their investigation b) collect data that answers the question c) collect data that is complete, accurate, and objective d) organize and display their data in graphs, tables and/or charts
Explain [observation/ inferences]	Explanation	a) patterns and relationships in data, b) observations and inferences c) use of evidence to develop explanation d) alternative explanations e) explanations that are consistent with evidence f) explanations that connect to scientific knowledge g) verification/refutation of hypothesis using results. h) use of formal labels, definitions, and	Teacher presents or identifies: a) patterns and relationships in data, b) observations and inferences c) explanations (without explanation of how it was derived from evidence) d) alternative explanations e) explanations (without explanation of how it must be consistent with evidence) f) explanations (without explanation that is must	Teacher guides students to: a) identify patterns and relationships in provided data b) differentiate between observations and inferences c) differentiate between explanations that are based on evidence and those that are not d) differentiate between appropriate and inappropriate alternative explanations e) differentiate between explanations that are consistent with evidence and those that are not f) differentiate between explanations that connect to scientific knowledge and those that do not	Teacher guides students to: a) identify patterns and relationships in their data b) develop and use appropriate observations and inferences c) provide underlying reasoning when proposing an explanation for their results d) propose alternative explanations that use scientific criteria to select the preferred explanation e) develop explanations that are consistent with experimental and observational evidence f) provide connections to scientific knowledge which supports their explanations

		explanations learned previously	connect to scientific knowledge g) verification/ refutation of hypothesis using results. h) formal labels, definitions, and explanations	g) differentiate between correct and incorrect hypothesis decisions h) comprehend formal labels, definitions, and explanations	g) use results appropriately to verify/refute their hypothesis. h) use formal labels, definitions, and explanations learned previously
Communicate	Elaboration	a) interpretation of results b) critical reflections of process, results, and conclusions of findings c) alternative explanations for results d) revisions and new ideas for the investigation e) defense of the process and findings	Teacher provides no opportunities for students to work in groups and communicate and discuss their investigations and findings. Teacher directly presents or provides: a) interpretation of results b) reflections of process, results, and conclusions of findings c) alternative explanations for results d) revisions and new ideas for the investigation e) defense of the process and findings	Teacher models processes and underlying communication rationale [NOS] to help students understand: a) how to communicate interpretation of results b) how to communicate critical reflections on of process, results, and conclusions of findings c) how to communicate alternative explanations for results d) how to communicate revisions and new ideas for the investigation e) how to defend the process and findings	Teacher systematically provides opportunities for students to work in groups and communicate and discuss their investigations and findings. Teacher guides students to develop and communicate: a) interpretations about the meaning of results b) critical reflections of process, results, and conclusions of own and others' findings c) proposed alternative explanations for results d) revisions and new ideas for the investigation e) defense of their process and findings
Apply	Application	a) new contexts and applications of concept b) new questions to extend the investigation	Teacher directly presents or provides: a) new contexts and/or applications of concept b) new questions to extend the investigation	Teacher models processes and underlying reasoning to help students comprehend: a) new contexts and/or applications of concept b) new questions to extend the investigation	Teacher guides students to: a) propose new contexts and applications of concept. b) develop new questions to extend the investigation

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Appendix D
Teacher Assessment of Student Inquiry Skills (Student Inquiry Rubric)

Teacher Assessment of Student Inquiry Skills:
MIDDLE SCHOOL (GRADES 6-8)

Date:___________________________
Student Code:_____________________
Teacher: ___________________________ **School** ________________________

Abilities necessary to do scientific inquiry:

	1. Beginning	2. Progressing	3. Proficient	4. Exemplary
A. Identifying Questions and Formulating Hypotheses that May be Examined through Scientific Investigations	Testing the question is not possible; hypothesis is missing or unclear ○	Formulates testable questions which lead to a scientific investigation; ○	Formulates testable questions and hypotheses that lead to scientific investigation ○	Formulates testable questions and hypotheses that are specific, based on scientific concepts, ○
B. Designing and Conducting a Scientific Investigation	Little attempt is made to control and manipulate variables; esign of investigation contains major flaws in sequence and logic; ○	Flaws are evident in identifying variables; design of investigation contains minor flaws; some teacher intervention is necessary ○	Identifies what variable is controlled and what variables are manipulated; design of investigation is sequential and logical; experimental design requires minimal teacher intervention ○	Identifies what variable is controlled and what variables are manipulated; design of investigation is sequential and logical to the hypothesis; ○
C. Using Appropriate Tools and Techniques to Collect and Record Data	Collects and records invalid data; uses inappropriate equipment and techniques; ○	Collects and records objective data; incorrectly uses equipment and techniques; requires some teacher intervention ○	Collects and records complete and objective data; uses appropriate equipment and techniques; requires minimal teacher intervention ○	Collects and records data which is complete, accurate, and objective; uses appropriate equipment and techniques; ○
D. Using Evidence to Develop Explanations and Describe Relationships between Evidence and Explanation	Students are unable to draw inferences (interpretation of an observation) ○	Students draw faulty inferences based on patterns or previously held ideas ○	Students draw inferences based on relationships, perceived patterns, or previously held ideas ○	Data is analyzed objectively; students draw logical inferences based on observed patterns and relationships; ○
E. Communicating Procedures, Results, and Explanations of a Scientific Investigation	Scientific information is unclear; presentation lacks focus and organization; medium hinders communication ○	Scientific information has some clarity; presentation has some focus and organization; medium permits communication ○	Scientific information is communicated clearly; presentation is focused and organized; ○	Scientific information is communicated clearly and precisely but may also include inventive/expressive dimensions; ○

HIGH SCHOOL (GRADES 9-12)

Date: _____
Student Code: _____
Teacher: _____ **School:** _____

	1. Beginning	2. Progressing	3. Proficient	4. Exemplary
A. Formulating Questions and a Hypothesis Statement	Is not able to formulate a testable hypothesis that answers the question ○	Formulates a hypothesis that may not answer the question; supported by opinions and misconceptions ○	Formulates a coherent testable hypothesis that potentially answers the question; partially supported by prior knowledge ○	Formulates a coherent testable hypothesis that potentially answers the question; completely supported by prior knowledge ○
B. Designing and Conducting Scientific Investigations	Designs and conducts a scientific investigation unrelated to the hypothesis; steps are not logical, not sequential, and/or are vague; ○	Relationship between the hypothesis and the scientific investigation lacks clarity; steps are missing and/or difficult to follow; ○	Designs and conducts a scientific investigation related directly to the hypothesis; steps contain minor inaccuracies in logic and/or sequence; ○	Designs and conducts a scientific investigation related directly to the hypothesis; steps are logical and sequential; ○
C. Using Appropriate Tools and Techniques to Collect and Record Data	Selects inappropriate equipment and techniques; does not employ safety when using lab equipment, ineffective use of technology and mathematical concepts; ○	Incorrectly uses equipment and techniques; some unsafe practices are evident; ineffective use of technology and mathematical concepts; errors present in collected data ○	Selects and safely uses lab equipment; generally chooses/uses appropriate technology and mathematical concepts; minor inaccuracies and some subjectivity in data collection ○	Selects and safely uses lab equipment; effectively chooses/uses appropriate technology and mathematical concepts; data is collected and recorded in a systematic, accurate, and objective manner ○
D. Formulating and Revising Scientific Explanations and Models Using Logic and Evidence	Explanations/models are not based on analysis of data or accurate science; data which refutes the hypothesis is discounted; ○	Explanations/models are based on flawed analysis of data and misconceptions of science; formulates limited revisions ○	Explanations/models partially reflect evidence from investigation and are based on accurate science; uses results to verify or refute the hypothesis; formulates possible revisions ○	Explanations/models reflect evidence from investigation and are based on accurate science; uses results to verify or refute hypothesis; ○

E. Communicating and Defending a Scientific Argument	Methods and procedures are unclear and inaccurately represented; arguments and responses to critical comments as well as the connections between the investigation and accurate scientific knowledge are missing ○	Methods and procedures are unclear or represented inaccurately; arguments and responses to critical comments as well as the connections between the investigation and accurate scientific knowledge are flawed ○	Methods and procedures are generally accurate to allow replication of the investigation and support the opportunity for further investigation; arguments and responses to critical comments contain some flaws in logic but generally demonstrate the connections between the investigation and accurate science ○	Methods and procedures are clearly and accurately represented to allow replication of investigation and enhance opportunities for further investigation; arguments and responses to critical comments are logical and effectively demonstrate understanding of relationships between the investigation and accurate science ○

Appendix E
Coaching Expectancy Pre-Survey

Coaching Expectancy Pre-Survey

Teacher name: _____ Date: _____

As you prepare to take part in an extended professional development study, please mark the following statements on a scale from 1 (Strongly Disagree) to 7 (Strongly Agree).

	Statements	Strongly Disagree			Neutral			Strongly Agree
1.	Working with an instructional coach will help me implement inquiry strategies into my classroom.	1	2	3	4	5	6	7
2.	Coaching will improve my ability to implement inquiry instruction in my classroom.	1	2	3	4	5	6	7
3.	I want to implement inquiry strategies into my instructional toolbox.	1	2	3	4	5	6	7
4.	An instructional coach will help me identify desired student outcomes for my classroom.	1	2	3	4	5	6	7
5.	An instructional coach will provide meaningful feedback regarding my inquiry teaching practices.	1	2	3	4	5	6	7
6.	Coach feedback will help me improve my students' understanding of science concepts	1	2	3	4	5	6	7
7.	My instructional coach needs to be competent in the subject matter I am teaching.	1	2	3	4	5	6	7
8.	The time I spend in coaching sessions will be time well spent.	1	2	3	4	5	6	7
9.	Coaching is a valuable part of the professional development process.	1	2	3	4	5	6	7
10.	It is important that I watch my classroom videos in preparation for the coaching session.	1	2	3	4	5	6	7
11.	I plan to implement the strategies suggested in my coaching sessions.	1	2	3	4	5	6	7
12.	Coaching will change my instructional practices in ways that benefit student learning.	1	2	3	4	5	6	7
13.	It is important that I trust my coach.	1	2	3	4	5	6	7
14.	Self-reflection on my teaching practice is valuable.	1	2	3	4	5	6	7

As you prepare to work with an instructional science coach as part of the CSI study, please respond to the following questions:

15. What do you hope to learn through working with an instructional coach?

16. What do you see as the biggest obstacles to working with an instructional coach?

Appendix F
Teacher Confidence Survey

Teacher Confidence Survey
(Complete after each coaching session)

Teacher name: _____ Coaching session date: _____

With your last coaching session in mind, please mark the following statements on a scale from 1 (Strongly Disagree) to 7 (Strongly Agree).

	Statements	Strongly Disagree			Neutral			Strongly Agree
1.	I am confident that I can guide students to formulate testable questions.	1	2	3	4	5	6	7
2.	I am confident that I can guide students to formulate hypotheses that are based on scientific concepts.	1	2	3	4	5	6	7
3.	I am confident that I can guide students to collect data that is relevant to the scientific question.	1	2	3	4	5	6	7
4.	I am confident that I guide students to identify variables within a scientific investigation.	1	2	3	4	5	6	7
5.	I am confident that I can guide students to collect data that is complete, accurate, and objective.	1	2	3	4	5	6	7
6.	I am confident that I can guide students to organize and display data in graphs, tables and/or charts.	1	2	3	4	5	6	7
7.	I am confident that I can guide students through questions to recognize patterns and relationships in data.	1	2	3	4	5	6	7
8.	I am confident that I can guide students to use scientific criteria to select the best explanation for their results.	1	2	3	4	5	6	7
9.	I am confident that I can guide students towards explanations that are consistent with evidence.	1	2	3	4	5	6	7
10.	I am confident that I can guide students in recognizing connections in scientific knowledge that supports their explanations.	1	2	3	4	5	6	7
11.	I am confident that I can guide students to effectively defend their findings to appropriate audiences.	1	2	3	4	5	6	7
12.	I am confident that I can guide students to transfer their knowledge of scientific concepts to new applications.	1	2	3	4	5	6	7
13.	I am confident that I can use guided questioning at various levels (e.g., understanding to analysis) to promote student development of concepts.	1	2	3	4	5	6	7
14.	I am confident in my ability to allow for students to design and carry out their own investigations.	1	2	3	4	5	6	7
15.	I am confident in my ability to implement inquiry instructional strategies in my classroom without additional coaching support.	1	2	3	4	5	6	7

Appendix H
Coaching Session Progress Summary

Coaching Session Progress Summary
(Completed by coach after each session)

Coach _____ Teacher name _____

Date of video: _____ Date of Session: _____ Session number: _____

Based on your observations and coaching experiences with this teacher to date, please mark the following statements on a scale from 1 (Strongly Disagree) to 7 (Strongly Agree) and 0 for Not Applicable/Not Observed.

	Statements	N/A	Strongly Disagree			Neutral			Strongly Agree
1.	The teacher effectively guides students to formulate testable questions.	0	1	2	3	4	5	6	7
2.	The teacher effectively guides students to formulate hypotheses that are based on scientific concepts.	0	1	2	3	4	5	6	7
3.	The teacher effectively guides students to collect data that is relevant to the scientific question.	0	1	2	3	4	5	6	7
4.	The teacher effectively guides students to identify variables within a scientific investigation.	0	1	2	3	4	5	6	7
5.	The teacher effectively guides students to collect data that is complete, accurate, and objective.	0	1	2	3	4	5	6	7
6.	The teacher effectively guides students to organize and display data in graphs, tables and/or charts.	0	1	2	3	4	5	6	7
7.	The teacher effectively guides students through questions to recognize patterns and relationships in data.	0	1	2	3	4	5	6	7
8.	The teacher effectively guides students to use scientific criteria to select the best explanation for their results.	0	1	2	3	4	5	6	7
9.	The teacher effectively guides students towards explanations that are consistent with evidence.	0	1	2	3	4	5	6	7
10.	The teacher effectively guides students in recognizing connections in scientific knowledge that supports their explanations.	0	1	2	3	4	5	6	7
11.	The teacher effectively guides students to effectively defend their findings to appropriate audiences.	0	1	2	3	4	5	6	7
12.	The teacher effectively guides students to transfer their knowledge of scientific concepts to new applications.	0	1	2	3	4	5	6	7
13.	The teacher effectively utilizes guided questioning at various levels (e.g., understanding to analysis) to promote student development of concepts.	0	1	2	3	4	5	6	7
14.	The teacher effectively allows for students to design and carry out their own investigations.	0	1	2	3	4	5	6	7
15.	The teacher is prepared to effectively implement inquiry instructional strategies in their classroom without additional coaching support.	0	1	2	3	4	5	6	7

Did the teacher demonstrate evidence of having watched their teaching videos in preparation for this coaching session?

YES NO

Comment:

Please describe any unusual circumstances that may have impacted the lesson that was observed for coaching (e.g., homecoming week, equipment failure).

Appendix H

Institutional Review Board Informed Consent Form

University of Nebraska Lincoln

COLLEGE OF EDUCATION AND HUMAN SCIENCES
Nebraska Center for Research on
Children, Youth, Families and Schools

CSI: COACHING SCIENCE INQUIRY IN RURAL SCHOOLS
TEACHER INFORMED CONSENT FORM

CSI: Coaching Science Inquiry In Rural Schools is a professional development research study being conducted through the National Center for Research on Rural Education (R^2Ed) at the University of Nebraska-Lincoln. The purpose of this two-year study is to determine the impact of professional development with instructional coaching delivered via distance-based technology on guided scientific inquiry (treatment) versus no professional development (control) on (a) teacher inquiry knowledge, skills, self-efficacy, and beliefs, and (b) student inquiry knowledge, skills, and engagement.

Middle and high school rural science teachers will work with researchers to learn ways to use guided inquiry experiences in science lessons to maximize students' learning of scientific concepts and methods. As part of this research study, teachers will be randomly assigned to either a group receiving the professional development or a control group not receiving the training. Teachers assigned to the control group for the first year (2012-2013) have the first choice to participate in the professional development during the second year (2013-2014). Results will provide evidence regarding an effective method for teaching students in rural settings scientific inquiry concepts and processes, including the use of instructional coaching (via distance technology) in promoting teachers' knowledge, skills, and practice.

Teachers in the ***professional development with coaching treatment condition (treatment condition)*** will participate in an eight-day Summer Institute held over two consecutive weeks. During this time teachers will learn elements of guided inquiry instruction, spend time adapting an inquiry lesson for their classroom, and present their inquiry lesson to receive feedback from a designated coach and their teacher peers. This lesson will then be implemented in their classroom during a 6 - 8 week period during the following school year. Two lessons per week during this 6 - 8 week period will be video recorded for teacher self-reflection and coach review. Two distance-delivered (web-based technology such as Adobe Connects) coaching sessions will be held per week, where teachers and coaches jointly discuss successes and challenges and plan for future lesson implementation. The coaching sessions will also be video and audio recorded to provide data on coaching processes. In general, coaches will provide support and guidance to the teachers regarding effective classroom implementation of guided inquiry. Teachers in the treatment condition will be compensated for their time spent in professional development activities that are not part of their regular contracted teacher responsibilities. Specifically, teachers in the treatment group will be reimbursed $2200, to be paid out upon completion of key project milestones: at the conclusion of their time attending the eight-day summer institute ($100/day x 8 days = $800), completion of their unit submission and implementation for their time required for preparation, implementation and coaching sessions (10 days x $100 = $1000), and $400 to compensate for their time in completing and returning all student and teacher research instruments and to coordinate the needed videotaping (with $25 of this amount paid out for completing an initial video recordings prior to the Summer Institute). Treatment teachers traveling more than 60 miles one-way to the summer institute held in Lincoln, NE, will also have lodging costs covered and will be provided with a travel stipend calculated by the distance traveled.

Teachers in the control condition will provide information regarding their current practices. Teachers in the control condition will receive $400 for completion of the research instruments and coordination of the needed videotaping (with $25 of this amount paid out for completing an initial video recording prior to the Summer Institute).

All teachers (i.e., treatment and control groups) will provide information related to outcomes that will be assessed for each teacher via an inquiry knowledge test, inquiry self-efficacy questionnaire, inquiry beliefs questionnaire, and coded video recorded instructional sessions. Teachers will also complete an assessment of their individual student's inquiry skills to provide data regarding desired student outcomes. In addition, treatment teachers will complete a short coaching expectation survey to assess their perceptions of the coaching process as well as an inquiry teaching confidence survey after each coaching session (estimated 5 minutes.) Data collection will occur at four basic points, with different instruments being completed at each time point: (1) pre-summer Institute (approximately 70 minutes to complete); (2) post-summer Institute (approximately 55 minutes to complete); (3) post-classroom implementation of inquiry unit (estimated 105 minutes); and (4) end of school year (estimated 30 minutes). All teachers (i.e., treatment and control) will also submit video recordings for research coding in the spring prior to their participation in the Summer Institute, 2 - 3 times during the unit, and near the end-of-unit. Coaches and project research personnel will have access to the recordings for coding and reliability purposes. The videos will be kept for five years after the project is completed, and then will be destroyed. The videos will be stored digitally on a secure server maintained by the Nebraska Center for Research on Children, Youth, Families and Schools (CYFS) at the University of Nebraska-Lincoln.

All teachers participating in this project will contribute to the knowledge base regarding guided science inquiry for middle and high rural schools. Individual teachers in the treatment group will immediately benefit by receiving instruction and support for developing inquiry instructional strategies that foster student understanding of the inquiry process in addition to receiving direct, ongoing coaching to more successfully implement the inquiry model of instruction in their classrooms. Lesson plans are developed that are consistent with district curriculum, the State Standards, and are classroom ready. Participants will build a Nebraska network of science educators as instructional and support resources.

Any information obtained during this study that could identify you will be kept strictly confidential. All data from questionnaires and videotapes will be coded. Only members of the research team will have access to the coded data. The results obtained from this study may be published in scientific journals or presented at scientific meetings, but the data will be reported as aggregated group results without any information that would identify students, teachers, classrooms or schools. Databases that contain no teacher or student names will be maintained by the Nebraska Center for Research on Children, Youth, Families and Schools (CYFS) at the University of Nebraska-Lincoln.

Investigators on this project include Drs. Jon Pedersen, Gwen Nugent, and Gina Kunz. You may ask questions about this research and have those questions answered before, during, or after the study by contacting the lead Co-Principal Investigator Dr. Gwen Nugent at (402) 472-1009 or gnugent1@unl.edu. If you have questions about your rights as a research participant that have not been answered by the investigators, or to report any concerns, you may contact the University of Nebraska-Lincoln Institutional Review Board at (402) 472-6965.

You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigators, the University of Nebraska, or the school. You are voluntarily making a decision whether or not to participate in this research study. Your signature certifies that you have decided to participate having read and understood the information presented. You will be given a copy of this consent form to keep.

Printed Name of Teacher: _____

Signature of Teacher: _____ Date: _____

Name and phone number of Investigators: Gwen Nugent Office: (402) 472-1009; Gina Kunz (402) 472-4659.