THE USE OF COLLaborATION AND REFLECTION
IN A PAIRED STUDENT TEACHER PLACEMENT

by

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(Under the direction of Dr. Carolyn S. Wallace)

abstract

This study paired two student teachers and placed them into one science classroom. Their use of collaboration and reflection was investigated as the student teachers worked together in learning to teach science. A social constructivist theory guided the study as well as research from the areas of peer collaboration and reflection. Observations, interviews, and audiotapes of their co-planning sessions were used to interpret the data. The results revealed that many collaborative interactions emerged. However, two specific collaborative interactions were significant: division of teaching responsibilities and giving two explanations of the science content. Specific responsibilities that were divided among the student teachers were administrative issues, science content preparation, and science teaching. The student teachers gave two explanations of the science content while explaining the science content, giving directions, answering questions, and disciplining students. Reflection impacted the paired student teachers’ learning to teach science in significant ways. Several instances triggered reflection including dilemmas that occurred during student teaching and student feedback. From their reflection, the student teachers experienced growth in science teaching. This growth was evident in the areas of management, science content, and pedagogical content knowledge. Finally, this study uncovered the different mechanisms that were used to facilitate reflection. The specific mechanisms were the student teachers’ knowledge base from being a learner and suggestions, tensions, and support that were shared with their partner.

INDEX WORDS: Collaboration, Science, Paired student teaching, Social constructivism, Reflection
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CHAPTER 1
INTRODUCTION

Background

Student teaching is often the culminating event of the preservice teacher education program. Prior to student teaching, preservice teachers have completed most of their course work and some field (practicum) experience. Thus, student teaching allows preservice teachers to practice what they have learned in their educational program, learn new information from their teaching experience, and reflect on their teaching. Considering that student teaching is a critical opportunity for preservice teachers to apply what they have learned, educators have the responsibility to provide an excellent experience for them. However, there is little literature on the analysis of student teaching programs and their changing to meet the needs of current student teachers (Northfield, 1998).

Traditionally, in most teacher education programs in science education, one student teacher works with one cooperating teacher. This one-on-one plan works for some student teachers, but it is unsuccessful for others. Several research studies have examined why some preservice teachers have failed during their student teaching (Harwood, Collins & Sudzina, 2000; Knowles & Sudzine, 1992). The contexts of the placements may have been wrong for those who did not succeed (i.e., incompatible cooperating teacher, wrong grade level, etc.). Knowles and Sudzina (1992) suggested that teacher educators place student teachers together in the classroom.
Some problems associated with the practicum may be alleviated by placing small clusters or cohorts of preservice teachers together in schools and classrooms. In the contexts envisaged, the direct purpose is to encourage mutual support, collaborative and cooperative preparation, teaching, evaluation, and generally attempting to dispel the notion that teaching is performed in isolation and behind closed doors (p. 19).

The social constructivist theory of learning suggests that many students learn best when they collaborate with their peers (Cobb, 1994; Driver, 1995; Hatano, 1993). As Roth and Tobin (2001) pointed out, teaching with peers helps student teachers construct understanding, apply the content they were taught in their educational program, and build on their understanding of science teaching.

Problem Statement/Purpose of the Study/Research Questions

When science teachers work together, they have the opportunity to collaborate in many aspects of science teaching such as planning lessons, setting up labs, constructing tests, managing the students, and reflecting on their science teaching. Teacher collaboration is an extremely useful tool that many teachers do not take advantage of and that many preservice teachers never learn (Lemlech, Hertzog, & Pensavalle, 2000; Hertzog, Pensavalle, Lemlech, 2000; Roth & Tobin, in press). Collaborating with others provides opportunities for sharing problems, resolving conflicts, and gaining support (Brown & Palinscar, 1989). In addition to gaining assistance, collaboration may be a powerful tool in learning to teach science. Through collaboration, teachers may see different viewpoints and generate new ideas on how to teach. Collaboration not only enhances teaching skills, but working with peers allows teachers to reflect more on their science teaching (Lemlech, Hertzog, & Pensavalle, 2000).

A considerable amount of research exists on peer collaboration between experienced teachers, novice/experienced teachers, and student teachers/cooperating
teachers (Collins, Bercow, Palmeri, Altman, & Singer-Gabella, 1999; Flannery & Hendrick, 1999; Jones, Rua, & Carter, 1998; Roth & Tobin, 2001). Universities are also implementing paired student teaching at the elementary level (Bullough, et al., in press; Lemlech, Hertzog, & Pensavalle, 2000). However, there is little information on the collaborative work that occurs between peers during a secondary science paired student teaching experience. This gap in the literature hinders science educators from implementing the valuable approach of collaboration in student teaching.

The purpose of this study is to explore the use of collaboration in a paired science student teacher placement. In the context of collaborative peer teaching, I sought answers for the following research questions:

1) What types of collaborative interactions do the paired student teachers engage in, and how do these interactions facilitate learning to teach science?

2) What does reflection look like in paired student teaching? What evidence is there of reflection in paired student teaching?

Rationale

Because collaborative interactions and social negotiation are such potentially important parts of the learning process, a collaborative student teaching placement was arranged which placed two preservice students in the same science classroom during their student teaching. One cooperating teacher supervised the student teaching pair. In this setting, individuals become participants in an enhanced environment for socially constructing knowledge about science teaching.

There is a gap in the literature in the areas of paired student teaching in science education programs and the role of reflection in collaborative student teaching.
placements. This research study adds to the literature by giving science teacher educators direction for alternative student teaching placement. The findings of this research study also give teacher educators information about how collaborative student teaching can aid the reflective process in preservice education.

This research study contributes to the literature in the areas of the role of collaboration in learning to teach science and the role of reflection in a collaborative student teaching placement. Specifically, this study analyzed how paired student teachers collaboratively construct ideas about science teaching and the social processes by which they understand science teaching.

**Theoretical Framework**

**Overview**

School learning is an interactive process that occurs through experiences with different aspects of the school environment such as teachers, peers, and resources. What is learned is heavily influenced by what learners bring to the learning situation including culture, background, and previous knowledge. Learners in turn influence and are influenced by others.

Social constructivism is the overarching theoretical framework that guided this research study. Social constructivists theorize that individuals’ construction of meaning is influenced by their interaction with the social environment. Within the social constructivist framework, two specific theories guided this study: Vygotsky’s (1978) theory of internalization of psychological functions and Schön’s (1983, 1987) theory of reflection as a process of learning to teach.
Social Constructivism

Constructivists believe that knowledge is built in the individual’s mind according to that individual’s experiences. According to Berger and Luckmann (1966), “reality is socially constructed” (p. 1). We share our everyday lives with others, and social interaction helps us construct meaning of the world around us. We learn as we communicate with others, create symbolic representations, and use tools in the environment.

Social constructivism, like constructivism, is still concerned with an individual's construction of meaning. However, individual meaning is now influenced by the social processes with others, the environment, texts, etc. As Driver, Asoko, Leach, Mortimer & Scott (1994) point out, “scientific knowledge is . . . socially negotiated” (p. 5). Knowledge creation is not only an individual process; it is affected by negotiation with others. The individual is situated within a social context (Adbal-Haqq, 1998). According to Wertsch & Toma (1995), “key aspects of mental functioning can be understood only by considering the social contexts in which they are embedded” (p. 159). The environment in which learning takes place, including teachers, peers, texts, school, parents, etc., influences what is learned.

Social constructivism is based in large part on the work of Vygotsky (1978) who stated that we construct knowledge when we interact with the world. Hatano (1993) gives several assumptions about Vygotsky’s idea of social constructivism. First, learning is actively achieved by interaction with others. When students work with others, whether they work with peers, teachers, parents, etc., their learning is affected by what others bring to the situation. Learning is verbalized, discussed, argued, and (sometimes) agreed
upon by those involved. Communication with others helps the learner construct personal meaning through social interaction.

Second, learners look for understanding from what they learn (Hatano, 1993). That is, they “construct” what is being taught to them. When learning takes place, students work to make personal meaning of what is being learned. How does the new information fit in with their existing understanding? Does what is being learned change previous understanding? Students take information and make it fit into their lives.

Next, “learners’ construction of knowledge is facilitated by horizontal as well as vertical interactions” (Hatano, 1993, p. 156). Learners learn both from their peers (horizontal interaction) and from authorities such as teachers, texts, and parents (vertical interaction). Students are generally more receptive to receive information and advice from their peers than from a teacher or parent.

Finally, learning is enhanced when it comes from a variety of sources (i.e. teachers and peers). All of these assumptions from Hatano (1993) may be experienced when student teachers are paired. The paired student teachers have opportunities to learn through interaction with a variety of people, each other, their cooperating teacher, university supervisor, and their students. Working in groups enhances understanding by challenging group participants’ knowledge. Group members are able to change and expand the way they think when others question and criticize them. Inquiry by others compels group members to give specific details about their understanding and to defend their position (Brown & Palinscar, 1989; Webb, Troper, & Fall, 1995).

Working with others allows for mechanisms of the social construction of knowledge. Group members are provided with support from their collaborators, and the
group shares the accountability for decisions made. People with different expertise are brought together and can share their knowledge with all members of the group. The different strengths may be transferred to all, so that when working individually, group members will have a broader understanding (Brown & Palinscar, 1989; Webb, Troper, & Fall, 1995).

Social constructivism signifies the importance of learners having a social forum in which to learn. Vygotsky’s (1978) theory of internalization explains how learners first socially construct meaning of new information before that information is individually internalized.

**Vygotsky’s Theory of Internalization of Psychological Functions**

One of the initial phases in the development of a child is to use external signs as a means for learning. Vygotsky (1978) gives the example of a child learning to point. Initially, the child is simply grasping for an object. When seeing this gesture, his mother responds by helping the child obtain the object. The child learns that the pointing gesture causes a response from someone else and quickly learns to use the sign when desiring an item.

As the child matures, internal processes replace the use of external signs (writing oneself a note, tying a knot around one’s finger). However, Vygotsky emphasizes that development of a particular area of knowledge never ceases. Children go through the same processes as they mature; however, the development is as a “spiral, passing through the same point at each new revolution while advancing to a higher level” (Vygotsky, 1978, p. 56). So, children may continue to use external signs in higher learning, but it is
at a more advanced level. This ‘internal reconstruction of an external operation’ (Vygotsky, 1978, p. 56) is called internalization of psychological functions.

Internalization involves a series of stages. The first stage is that an operation being performed moves from external to internal significance. The learner begins to internally understand and make personal meaning of new information. The next stage involves a process being transformed from an interpersonal to an intrapersonal one. That is, the development becomes less social and more individual; ‘first between people and then inside the child’ (Vygotsky, 1978, p. 57). The last stage states that this transformation is not simple, it involves a ‘long series of developmental events’ (Vygotsky, 1978, p. 57). Vygotsky (1978) explains that it takes a long period of time and many developmental steps for a concept to be internalized. However, internalization is not just the transfer of the external to the internal; it involves how we form the internal structures (Blanck, 1990).

People internalize concepts as they learn more about them. Some concepts are internalized quickly while other concepts are never internalized. Internalization indicates a growing developmental level; concepts that are internalized make sense to us. And working collaboratively with peers can enhance internalization. ‘Social interaction between peers who bring different perspectives to bear upon a problem is a highly effective means of inducing cognitive development’ (Tudge, 1990, p. 159). Working with peers allows the learners to work with someone else and talk about the learning which may enhance understanding.

Preservice teachers learn the external signs for teaching including terms, definitions, and methods. As they learn more about teaching, the signs become more
understandable and begin to be internalized. Often, preservice teachers practice in front of their peers and professors as they begin to internalize the science teaching process. They are allowed to observe classrooms of school children, work with small groups of students, and practice a lesson or two with supervision. The preservice teachers are often placed in practicum situations where they observe and teach in the same classroom for several weeks at a time. Finally, at the end of the undergraduate preservice education program, student teachers are allowed to take over a classroom of students for several weeks. Internalization may occur at all levels of learning to teach, especially during student teaching.

Vygotsky’s theory of internalization suggests that it is important for researchers to consider both the individual and social processes when studying construction of knowledge. Cobb (1994) explored this dilemma as he considered the debate between the radical constructivist’s notion that learners construct their own knowledge and the sociocultural theory which emphasizes that “an individual’s activity is profoundly influenced by his or her participation in encompassing cultural practices” (p. 13). The question coming from the dilemma is whether the mind should be ‘located in the head or in the individual-in-social-action’ (Cobb, 1994, p. 13). Is learning an individual or group process?

Cobb (1994) suggested that learning requires a combination of both individual interpretation and social practices. ‘Sociocultural analyses involve implicit cognitive commitments, and vice versa. It is as if one perspective constitutes the background against which the other comes to the fore’ (p. 18). Individual meaning making involves more than personal construction of knowledge. Learning is drawn from the environment
in which it takes place. On the other hand, social processes are made significant when an individual can personalize them. Social practice only makes sense in light of the individual knowledge one brings to the social arena. One can only understand her own teaching ideas against a backdrop of others’ knowledge and practice.

Cobb’s (1994) analysis emphasizing both social and individual constructions of knowledge is significant. His explanation of both individual and social aspects of learning illustrates how teachers use both processes to assist in their conceptual understanding of science teaching. Paired student teachers can come to understand science teaching in a social and personal context.

Reflection

One possible mechanism for facilitating internalization is reflection. In the 1980s, Schön (1983, 1987) argued for a new framework of educational practice – one in which schools promoted reflection in all areas of study. The universities were teaching research-based courses that were not meeting the demands of the students. The practical elements of education were not being addressed. Building on Dewey’s work of constructivism, Schön (1983, 1987) stated that students must be actively involved in their own learning instead of merely being supplied with information. He contended that schools should include reflective practice as a part of their curriculum (Schön, 1983, 1987). Schön (1983) described reflection as a way individuals deal with problematic situations. People are faced with uncertain situations that force them to become open to new ideas.

Reflection serves to bring people out of their repetitive nature and forces them to look at their practice (Schön, 1983, 1987). Many times teachers get into a routine of
teaching, and they do not take time to assess themselves and improve their practice. Reflection promotes improvement by causing teachers to analyze their teaching. Schön (1983, 1987) described the process of framing and reframing a problem in order to analyze and refine it. Framing refers to the way teachers view a teaching situation. Teachers reflect on their frames in order to resolve troublesome circumstances. Reflection on the frames can lead to alternative views of the teaching situation, a process where teachers reframe their teaching conceptions. Teachers may also need to reframe and reframe again in order to successfully reach their goal.

Reflection is a tool that can be used by teachers to improve their practice.

Reflection is “a process of re-evaluating and reforming one’s existing theories in light of perturbing evidence” (Abell & Bryan, 1997, p. 154). Reflection causes teachers to think about their teaching practice in order to modify their actions. Reflection is often initiated when teachers run into a difficult situation and seek a solution. Reflection is also clarifying, confronting, and expanding one’s ideas, beliefs, and values about science teaching and learning (Abell & Bryan, 1997). Reflection may be an important process for fostering internalization of teaching concepts. By allowing student teachers to verbalize their teaching dilemmas with their peer, paired reflection promotes social problem solving which, according to Vygotsky’s (1978) internalization, may lead to individual understanding.

Hatton and Smith (1995) described reflective practice occurring once teachers have thought through specific dilemmas. Teachers verbalize specific ideas about teaching with others in order to create individual meaning and understanding. Hatton and Smith’s (1995) notion of reflection gives teachers an avenue for internalizing scientific
concepts. They showed how important the social arena is for making reflection successful. They also pointed out that group discussions are important to facilitate reflection. However, there are some problems that occur that prevent teachers from developing their reflective selves. These problems, described below, may be limited by pairing student teachers.

Many teachers do not have the time or opportunity to reflect (Hatton & Smith, 1995). Pairing student teachers facilitates reflection by creating more opportunities for reflection to occur. Pairing provides additional time, a close association (i.e. they get to know each other), and a common experience base. The paired student teachers have the same students, the same classroom, and the same mentor which eases the reflection process.

In order to become successful reflective practitioners, preservice teachers need to communicate about their learning to teach processes. However, many preservice teachers find it difficult to talk with their cooperating teacher; the student teachers usually only have a listening role with their cooperating teacher (Lemlech, Hertzog, & Pensavalle, 2000). Hatton and Smith (1995) pointed out that a solution is to have teachers work with their peers, their ‘critical friends’ (p. 37). Peer collaboration in reflection allows the student teachers to be more expressive and free with their ideas.

“A powerful strategy for fostering reflective action is to engage with another person in a way which encourages talking with, questioning, even confronting, the trusted other, in order to examine planning for teaching, implementation, and its evaluation” (Hatton & Smith, 1995, p. 41). Pairing student teachers not only assists in developing reflective teachers, it also provides the circumstances for reflection to enhance the
internalization of learning to teach science. In this research study, reflection involved having student teachers think about their science teaching, discuss and critique teaching strategies with their student teaching partner, re-examine their practices, and identify alternatives to challenging and difficult decisions.

**Summary**

Social constructivism and Vygotsky’s (1978) theory of internalization suggest that learners should have a social context in order to internalize new information. Learners need interaction with their environment. This interaction includes peers, teachers, parents, texts, equipment, etc. Students are able to use these social factors to facilitate learning. Learning is then enhanced when students are able to reflect on their actions. The following chapter further explains the importance of the social component of learning. Social constructivism and reflection are tied to peer collaboration as literature from past research studies support the notion of the social construction of new concepts.
CHAPTER 2
REVIEW OF THE LITERATURE

Overview

Literature from several areas informed this dissertation research: peer collaboration, social constructivism, and reflection. The past literature from these areas contributed to my dissertation giving the study a meaningful basis and useful suggestions.

Literature on Peer Collaboration

Overview. Peer collaboration has been an important part of education for many years. The valuable tool of collaboration that enhances competency as a teacher has been used by elementary, middle, and high school teachers as well as in teacher education programs and among university professors. The research on peer collaboration highly recommends that it be used as a tool for teachers to grow. However, there is little research on student teaching peers working with other student teachers (Beneditti & Reed, 1998). The literature review on peer collaboration discusses the purpose and guidelines for peer collaboration, what is accomplished when collaboration is implemented, and advantages of collaboration to student teachers, schools, cooperating teachers, and universities.

Purpose and definition of collaboration. Peer collaboration in this research study involved two student teachers working together to learn how to teach science. The two student teachers worked together in all aspects of science teaching including planning and teaching the lesson, grading papers, and creating notes, student assignments, and class
activities. The student teachers reflected on their science teaching and their students and made changes when needed.

Roth and Tobin (2001) defined peer collaboration as “shared practice.” They advocate and have researched team teaching during student teaching. In their research study, team teaching was between one student teacher, her cooperating teacher, and her university supervisor. Roth and Tobin (2001) suggested that knowledge is learned when teachers are in the classroom with others. Learning how to teach occurs when students are able to communicate with their colleagues and work through difficult situations.

In my research study, peer collaboration is defined as two teachers working, reflecting, and learning together in the same science classroom environment. The student teachers in my study, Brittany and Diane, depended on each other as a peer teacher, collaborative disciplinarian, reflective partner, and critique cohort. Brittany and Diane worked together in every phase of their student teaching. Some of the teaching activities that Brittany and Diane shared are listed below:

- observing each other and other teachers;
- planning biology and physical science lessons;
- presenting the science lessons, labs, and class activities;
- preparing class materials, labs, and tests;
- researching the science content;
- disciplining students; and
- reflecting on their science teaching and making adjustments.

Making teaching explicit. A big problem for many teachers is changing and improving their teaching practices. Their teaching practices often remain hidden and implicit. Roth (1998) conducted a study in which two teachers collaborated to teach elementary science. One of the teachers was an elementary teacher, and the other collaborator was a graduate student. The two teachers planned together, taught the
curriculum together, had regular meetings about the lessons, and reflected about their collaboration. Roth’s (1998) study of the two collaborating teachers found that “their co-participation provided Tammy and Gitte with many opportunities to make aspects of their teaching explicit. Once explicit, these aspects contributed to a change in their professional discourse in which they make sense of the classroom events” (p. 367).

When the teachers worked together, they could specify their teaching practices in order to make improvements.

**Facilitating reflection.** Several studies have pointed out how important it is to observe another teacher, critique her, help her resolve any problems, and build upon her strengths (Allred & Baird, 1971; Martin & Double, 1998; McFaul & Cooper, 1984). Not only does collaboration allow student teachers to receive feedback from their peers, but it also allows them to learn how to look for strengths and weaknesses in their own teaching. When student teachers observe and suggest improvements, they construct an understanding of what constitutes effective teaching and are more able to reflect upon their own teaching actions. Student teachers are facilitated “to develop personal skills of evaluation and self-appraisal” (Martin & Double, 1998, p. 162) when they observe each other.

Baird, Fensham, Gunstone, and White (1991) emphasized the importance of using collaboration for promoting reflection. In their study, the participants were student teachers who individually student taught for one year. During student teaching, the preservice teachers took courses in which collaboration with other student teachers was a main component. They worked together on activities, held in-depth discussions, and reflected together about their individual teaching situations. The student teachers valued
group work as one of the most helpful components of their science education course.

One of the participants stated, “I realized how important learning from peers is! The discussions we had, the feedback, the encouragement, was very important, not to mention acceptance!” (p. 169).

Roles. Student teacher collaboration allows for the teachers to take on a variety of responsibilities and roles (Bullough, et al., 2002; Sterns, 1972). The student teacher can be the “full-time” teacher, an observer, a small-group leader, a large-group leader, a lab instructor, a tutor, an assistant, and a teacher to her peer. The number of roles a teacher can assume is doubled when there is another teacher with whom to work. Collaboration allows paired student teachers to practice more science teaching roles than if student teaching individually. Thus, teachers who plan and teach together often have better teaching actions than do individual teachers (Bauwens & Hourcade, 1995). Along with assuming more teaching roles, team teaching can reduce the student-teacher ratio by having an additional teacher in the class (Bullough, et al., 2002; Sterns, 1972).

Learning content and pedagogy. By pairing student teachers with different strengths, both learn from the strong points of the other. Student teachers may see how different aspects of science learning can be incorporated into various lessons. Incorporating different science teaching methods may be done more quickly than if student teachers teach independently (Lemlech, Hertzog, & Pensavalle, 2000). Many times, novice teachers learn new techniques of teaching over several years. However, being paired during student teaching allows for a variety of ideas to be shared before the teacher even begins teaching full-time.
By having a variety of viewpoints, collaboration can help bring the best solution to the most challenging problems. Vail, Tschantz, and Bevill (1997) described two situations when peers helped each other learn pedagogy. In one instance, one of the authors, a “special” education teacher, used peer collaboration to teach a “regular” education teacher about child-directed/initiated instruction. In a second case, another author, also a special education teacher, helped regular education teachers learn how to deal with problem behaviors of students with developmental delays. In both cases, the teachers learned from each other and exchanged ideas for improvement in specific situations. Peer collaboration puts teachers with different perspectives together and fosters peer learning.

By having more than one other teacher in the classroom, team student teaching prevents the student teacher from automatically modeling the behavior of the cooperating teacher (Allred & Baird, 1971; Cox, 1981; Lemlech, Hertzog, & Pensavalle, 2000). In an early study on collaborative student teaching, Allred and Baird (1971) placed three secondary student teachers together in one social studies classroom. Forty-eight social studies student teachers were placed in one of four categories: no student teaching, individual student teaching in traditional education preparation, individual student teaching in I-STEP (Individualized Secondary Teacher Education) preparation, or collaborative student teaching in I-STEP preparation. All of the collaborative student teachers were placed in three-member teams. The data favored collaborative over individual student teaching.

Team teaching allows for greater individualization of teaching and student learning, changes the self-image of prospective teachers positively, provides additional teacher models and helpful peer evaluation, aids trainees in maintaining composure during stress situations, permits significantly greater involvement of
school children in learning tasks, encourages more frequent and appropriate teacher reinforcement behavior, and yields less teacher initiated talk (Allred & Baird, 1971, p. 1).

To study preservice collaboration, Cox (1981) paired six secondary social studies teachers. Each pair was placed with one cooperating teacher. Four student teachers taught individually (the control group). The study sought to observe how collaboration between the paired student teachers affected their student teaching. The study showed that paired student teachers used more teaching techniques than student teachers who taught individually. By using more techniques, students with different learning styles may be able to learn the subject. The paired student teachers had more elaborate plans and used more diverse evaluations. Also, the paired student teachers engaged in deeper reflection of their teaching such as “grounding, probing, justification, and conceptualizing” (Cox, 1981, p. 20) within their subject area. Both the Allred and Baird (1971) and the Cox study (1981) showed that student teachers are able to learn content and pedagogy from each other when placed in collaborative student teaching placements.

Learning pedagogical content knowledge. Shulman (1987) was one of the first to use the phrase pedagogical content knowledge (PCK). He explained that a teacher’s knowledge consists of a number of domains including informal knowledge, subject matter knowledge, pedagogical knowledge, and pedagogical content knowledge. Informal knowledge is the everyday information about teaching that comes from teachers’ experience as students. Subject matter knowledge is knowledge of the content (science, reading, mathematics, etc.) teachers obtain from their formal education. Pedagogical knowledge is the information teachers learn about how to teach students.
Pedagogical content knowledge specifically refers to the knowledge teachers have about their subject matter in terms of teaching it to their students. PCK includes:

- knowledge of different frameworks about teaching a subject,
- knowledge of student understanding and misunderstandings of a subject,
- knowledge of curriculum,
- knowledge of the content, and
- knowledge of pedagogical strategies for a specific subject.

First, teachers have knowledge about why they are teaching their content. The beliefs about the goals for education affect teachers’ decisions about the lessons. Second, teachers have knowledge of student learning. Teachers use this knowledge to understand where students may misunderstand a concept, what the varying levels of student learning are, and how to offer alternative explanations to students.

Teachers also have knowledge about the curriculum they are teaching. Teachers are aware of materials to use and guidelines to help them teach. Next, teachers possess knowledge about the content they are teaching. This differs from general subject matter knowledge in that it refers to how teachers utilize the content knowledge in teaching their students. Finally, teachers have knowledge about pedagogy. Teachers learn various methods for presenting the content to their students.

De Jong (2000) proposed that prospective teachers have knowledge about their subject matter but often lack the understanding necessary to convert this to pedagogical actions. To explore this, De Jong (2000) studied preservice teachers’ lesson preparation techniques. Fourteen preservice chemistry teachers individually prepared one lesson plan. Then, the teachers explained their lesson plan in an individual interview and then to a group of preservice teachers. During the explanations, the preservice teachers were
asked questions about their concerns of their own pedagogical content knowledge (pedagogical content concerns, pcc).

De Jong’s results determined three areas of concern that the teachers had about their pedagogical content knowledge. First, they had self-pedagogical content concerns (self-pcc) where they reported lack of knowledge in the subject area. The preservice teachers also expressed task-pcc, having trouble with how to teach the content. Finally, the preservice teachers voiced student-pcc stating difficulties knowing about student learning.

The preservice teachers in De Jong’s (2000) study expressed similar concerns about their pedagogical content knowledge in both individual and group interviews. In the group settings, the teachers talked less about their self-pcc. However, the group setting provoked more discussion about task-pcc. All members of the group were able to talk about different strategies of teaching, thus learning from each other. De Jong (2000) suggested that teacher educators use group settings to discuss and help make teacher’s pedagogical content knowledge and concerns explicit.

Borko and Livingston (1989, 1990) studied teaching differences in expert and novice mathematics teachers. The novice teachers were student teachers, and their cooperating teachers were the expert teachers. Observations and interviews allowed the researchers to recognize differences in their teaching. One of Borko and Livingston’s (1990) most notable findings was that the student teachers ‘seemed to have limited pedagogical content knowledge about student learning in their subject area. . . . We speculate that they may have failed to realize the importance for student understanding of highlighting specific concepts or of communicating the big picture’ (p. 384). On the
other hand, the expert teachers possessed pedagogical content knowledge and were able to successfully organize the lesson so that their students understood the content.

One of the recommendations Borko and Livingston (1989) suggested was to limit the number of classes for which student teachers were responsible. This ensured that student teachers prepared “high quality content presentations” and “enhanced the student teachers’ development and elaboration of schemata for pedagogical content knowledge” (p. 493). Interestingly, in the study by Lemlech, Hertzog, and Pensavalle (2000), one of the initial negative reactions about pairing student teaching was that it would cut down on teaching time. This exact concern is what Borko and Livingston (1989) suggest that student teachers need to develop well thought out lessons.

Lemlech and Hertzog (1999) found similar results that student teachers are often limited in the area of pedagogical content knowledge. The paired student teachers in their study were very dependent on their cooperating teacher on “what a given community of learners needs to be taught, how the content should be sequenced, what resources to use, and how to assess what students have learned” (p. 18). By pairing student teachers, partners can help each other develop their pedagogical content knowledge and practice teaching methods using PCK.

**Schools and cooperating teachers.** In addition to collaboration benefiting the teachers, schools also benefit from teachers working together. Teachers and administrators are allowed to become more knowledgeable together. Collaboration lessens the amount of time that each teacher has to plan for instruction thus allowing for more developed lesson plans. Schools are more organized and better prepared for a wide variety of instructional skills, and teachers are happier and less stressed which reduces the
chance of their leaving (Inger, 1993). Students of collaborating teachers not only receive science information in creative ways, but they are able to see professional adults working together, learning from each other, and hopefully achieving successful collaborative practices. Collaboration creates a community of learners (Collins et al., 1999) where students see teachers work together, and the students tend to follow the collaborative model set by their teachers.

Cooperating teachers may also learn from their paired student teachers (Lemlech, Hertzog, & Pensavalle, 2000). When individual student teachers are placed in a classroom, they are more likely to copy the teaching strategies used by their cooperating teacher (Lemlech, Hertzog, & Pensavalle, 2000). In contrast, paired student teachers are more likely to utilize teaching strategies that were learned at the universities since they have their partner for assistance and support. Thus, cooperating teachers who mentor paired student teachers see the innovative strategies being used and are more likely to emulate the tactics learned from the student teachers (Lemlech, Hertzog, & Pensavalle, 2000).

Pairing student teachers may allow more student teachers to be placed in qualified cooperating teachers’ classrooms. Placing more student teachers into fewer classrooms helps the university by cutting down on faculty travel time and allowing them to spend more quality time observing their student teachers. However, cooperating teacher shortage should not be the driving force for implementing a collaborative teaching program (Lemlech & Hertzog, 1999). Although this section of information is not a direct focus of this study, it is relevant and interesting for collaborative research.
Comparing paired and single-placement student teaching. Bullough and associates (2002) recognized the need to restructure the traditional student teaching model and offer alternative student teaching placements. Therefore, they organized a comparative study of student teachers placed individually or in pairs. Twenty-seven elementary preservice teachers at Brigham Young University participated in the study; 12 were paired for their student teaching while nine student teachers taught individually.

In this study, Bullough et al. (2002) sought to examine the role of collaboration between paired student teachers, collaboration between mentors and their individual or paired student teachers, the relationship between student teaching pairs, and the impact of paired student teaching on mentors and student teachers. Interviews, time logs, and transcripts of planning sessions were used to answer the research questions.

The results reported that mentor teachers in the paired placements tended to be more of a team member in paired student teaching as they assisted the student teaching pair in planning. On the other hand, mentors of individual student teachers were more disconnected and absent from the classroom. Student teaching pairs were supporters of their partners having great interest in their partner’s teaching success. Paired student teachers also spent 30% more time planning and assumed more roles in the classroom than individual student teachers.

Implications for my Research. Many research studies have shown how successful teacher collaboration can be for all involved. Collaboration occurs in all kinds of environments: between university faculty, between a student teacher, cooperating teacher and/or university supervisor, and between peers. By having a student teaching partner, it is easier to recognize teaching practices and improve upon them. If student teachers
know how to work in teams, they can implement collaboration into their full-time teaching.

**Literature on Social Constructivism**

**Overview.** Social constructivism asserts that social processes influence an individual’s construction of knowledge. Learners interact with many aspects of the learning environment: peers, teachers, texts, society, equipment, etc. All of these contacts influence how learners construct personal meaning of information. Most of the literature on social constructivism discusses learning in groups and focuses on science learning in K-12 students. However, teacher education can learn from these studies to enhance preservice collaborative activities.

**Teacher knowledge.** Adams and Krockover (1997) designed a study to investigate beginning teacher knowledge and to show how much of this knowledge can be attributed to their preservice education programs. The study was based on the framework that teachers construct meaning based on their learning experiences. Adams and Krockover (1997) assumed that the experiences in a teacher’s preservice education lead to construction of teacher knowledge if these experiences are meaningful to the teacher.

To study teacher knowledge in relation to preservice education, Adams and Krockover (1997) interviewed and observed four beginning secondary science teachers with less than three years of teaching experience. The researchers used the teacher education program at Glass University (a pseudonym) as a source for teacher knowledge. The preservice education program emphasized “general pedagogical knowledge, pedagogical content knowledge, and a constructivist-based, student-centered perspective for learning” (p. 642).
All four of the teachers attributed much of their teacher knowledge to their preservice education programs. However, they also point to significant learning experiences such as being a graduate teaching assistant and to their current teaching situation as sources of their teacher knowledge. Adams and Krockover (1997) also found that some of the teaching concepts learned in the teacher education programs were not instantly applied but appeared over a period of time. One of the teachers adjusted his teaching to a more constructivist framework in his third year of teaching only after being asked to reflect on his teaching. An important implication that Adams and Krockover (1997) suggest is that teachers are given a forum for reflection. Pairing student teachers provides this forum for reflection.

**Making ideas explicit.** Duit (1995) recommended the use of social interactions for individuals to learn new science content. When groups of students discuss ideas, it is less likely that they will hold on to misconceived concepts. But, the teacher must guide the groups’ learning (Duit, 1995).

Driver (1995) reinforced the point that social interaction helps clarify students’ understanding. She studied interaction between a group of adolescents who were studying the process of water changing state. The group discussed what was occurring in the process of phase change and organized their knowledge to explain the concept. Driver (1995) asserts that learning through social interaction ‘provides a forum in which previously implicit ideas can be made explicit and available for reflection and checking’ (p. 394). Working with peers also allows the students a chance to refine their understanding and a chance to build off of their peers’ understanding (Driver, 1995).
Peer collaboration to facilitate learning. Webb, Troper, and Fall (1995) support the use of collaborative groups to enhance constructive activity. Their study placed seventh-grade students in small groups to cooperatively learn two mathematics units. Small groups allow learners to ‘learn from other students by giving and receiving help; by recognizing contradictions between their own and other students’ perceptions, seeking new knowledge to resolve those contradictions, and constructing new understandings from them; and by internalizing problem-solving processes and strategies that other students use or that are created jointly with others” (Webb, Troper, and Fall, 1995, p. 406).

At the end of each mathematics unit, the students were given a posttest. After analyzing transcripts of group interaction and the posttest scores, the study showed that the more a student participated in the cooperative group, the higher he scored on the posttest. The results revealed that talking through their understanding gave students opportunities to work through contradictions in search of a better explanation. Many times learners learn better from their peers than from a more experienced individual. Sometimes, peers understand better than the teacher what is misunderstood, and peers can explain new information in everyday terms (Webb, Troper, and Fall, 1995).

A study by Lumpe and Staver (1995) also recognized how peer collaboration enhances cognitive development. The purpose of the Lumpe and Staver (1995) study was to determine the role peer collaboration played in learning new science concepts. Twenty-five high school biology students participated in the study. Eighteen students were assigned to six collaborative groups (treatment group), and seven students worked individually (control group).
All of the students completed the same activities, lessons, and questions about how plants get their food. The treatment groups worked together on the tasks while the control group worked alone. The results reported that the treatment group scored higher on posttest assessments than did the students working alone in the control groups. The posttest scores indicated that the students working collaboratively acquired more correct explanations about photosynthesis than did the control group.

Lumpe and Staver (1995) subsequently chose one group (the group with the highest posttest scores) to further analyze the role of peer interactions in learning new science concepts. They found that peer collaboration helped the group members discuss the science concepts in detail and change their prior scientific misconceptions into correct concept development. The researchers also found that two types of specific interactions, consonant and dissonant, helped group members work through the information. Consonant discourse was the positive, friendly communication by the group (i.e. agreement, providing help) while dissonant discourse was more negative conflicts occurring in the group (i.e. argument, criticism of other’s ideas).

Richmond and Striley (1996) also conducted a study that examined the scientific knowledge construction in peer groups. Their study specifically focused on how students socially construct scientific knowledge. Richmond and Striley (1996) approached their study with the framework that students’ scientific knowledge is influenced by their collaboration with their peers. Students’ construction of knowledge is ‘shaped and validated largely by peers with whom they work and with whom they share certain goals’ (p. 840).
Twenty-four, tenth-grade students were assigned to one of six different groups. The researchers audiotaped all of the groups and videotaped two groups as they investigated four different laboratory experiments. The researchers looked at the verbal discourse that occurred among the groups of students and analyzed how this discourse affected the students’ scientific understanding.

Richmond and Striley (1996) found that most students made significant progress in their scientific understanding. Students assisted each other as they learned how to construct an argument of their lab experiments based on the scientific method. As this knowledge of scientific arguments increased, engagement in the groups increased for most students. The researchers found that the students assumed one of four roles: helper, active noncontributer, passive noncontributer, and leader.

The Webb, Troper, and Fall (1995), Lumpe and Staver (1995), and Richmond and Striley (1996) studies emphasized that working collaboratively with peers can assist students in developing knowledge. The students who worked collaboratively had better developed understanding of the math or science concepts than those who either worked alone or participated little in the peer groups. Participation in social processes influences understanding of scientific knowledge. All three studies acknowledged the importance of peer collaboration and encourage more use of it in the classroom.

Collaboration and reflection. Newell (1996) designed a university course that utilized collaboration and reflection as the main components of educating secondary inservice teachers. The course was based on a constructivist framework with ‘collaboration providing social support for reflection and opportunities for learning from peers” (p. 568). Forty-one teachers participated representing all subject areas.
The goal of the course was to elicit change in the teachers’ views of teacher effectiveness. To study teacher effectiveness, the teachers participated in three types of collaboration: base grouping consisting of teachers from the same discipline; jigsaw grouping containing one teacher from each discipline; and whole class discussion. The teachers were asked to reflect on the discussions they had in their collaborative groups, the movies they watched which illustrated teacher effectiveness, and the course itself. Three data sources were used: concept maps at the beginning and end of the course, written essays throughout the course, and interviews.

The results of Newell’s (1996) study revealed that working with teachers from the same and different disciplines broadened teachers’ awareness of teacher effectiveness. The teachers reported that the different groupings helped them better understand the material by presenting a variety of perspectives. The groups were allowed to collaboratively work through a new concept which is appropriate for social constructivist practice.

Another study by Roberts (1998) described how social constructivism can be used to promote collaboration and cooperative learning in children’s learning. He explained a constructivist program designed to help elementary students learn math concepts. Roberts (1998) explained how placing students in a social setting allows them to work together to learn the concepts for conservation of length (equal lines placed irregularly) and volume of liquids (equal amounts of liquids in different shaped containers).

In both of the tests, there were students (conservers) in the group who understood that both the lines placed irregularly and the liquids in different containers were equal. Other students (non-conservers) thought that one line was longer, one shorter and the
containers contained unequal amounts of liquid. For both tests, conservers in the group helped explain the concept to the non-conservers. In each case, the students who didn’t initially understand learned the concept with the help of their peers. The social constructivist environment assisted students in understanding difficult concepts.

In a similar study, Roth (1990) described the importance of social constructivism in learning science. Roth (1990) explained how he used constructivism and collaboration in his high school physics classroom. For various physics concepts, groups of students designed their own experiments to help them learn and explain the physics phenomena. Students weren’t given traditional “cookbook” labs but instead depended on the group’s knowledge to decide on the experimentation. Thus, different groups designed different experiments that facilitated further collaborative discussion amongst the class.

Roth (1990) found that students were required to work together to design the physics experiments. Students used their different areas of expertise (math, computer skills) to add to the group’s knowledge. Roth (1990) challenged educators to create more engaging and critical classrooms that will support students’ thinking and learning. Appropriate for this challenge is the social environment that promotes collaboration among learners.

Implications for my research. Collaboration can enhance the student teaching experience by pairing student teachers. When student teachers are paired, they can bounce ideas off of each other, critique each other’s teaching and planning, and come up with the best possible plan for teaching. Observing their partner will show the paired teachers how to look for improvements in their own teaching. Student teachers may experience more in-depth reflection with a partner and may utilize more science teaching
strategies than by student teaching alone. The participants in the above studies learned from their peers by collaborating in different contexts. These studies indicate that paired student teaching will increase the knowledge bases for teaching.

**Literature on Reflection**

**Overview.** Reflection is an educational concept that has been around for many years. Reflection can be used to promote internalization of teaching concepts, and it is an important process that teachers can use to facilitate teacher development. Reflection can be used in individuals, pairs, or groups to enhance teacher understanding.

**Description and stages of reflection.** John Dewey (1991) was one of the first educators to emphasize the importance of reflective thought in education. He described reflection as being more than a series of ideas; reflective thought involves thinking about future events while reflecting back on past experiences. Teachers do this when they use previous understanding to help them make on-the-spot decisions.

Dewey (1991) stated that reflective thought involves two stages: a state of doubt and an investigation to find evidence that supports or rejects the doubt. Teachers seem to be more apt to reflect when a problem arises – a student’s grades suddenly drop, a lesson isn’t understood, a teaching strategy fails. When teachers encounter dilemmas, they want to find out how they can improve the situation. So, they reflect upon the problem – what could cause a student’s grade to drop, why the lesson wasn’t understood, what made the teaching strategy fail. Reflection helps teachers find a solution to the most difficult problems.

**Reflection as a tool for internalization.** Using Dewey’s stages of reflection, reflective thought can be seen as a tool to promote internalization. Dewey suggested that
the evidence in stage two of reflective thought can be prior experience, observations, or help from others. Teachers internalize concepts by first working with others (Vygotsky, 1978). Internalization involves social mediation in order to make personal meaning of new information. Collaborating with others enhances the reflective process by providing more evidence to the problem that has occurred. For example, if a teacher has a problem implementing a teaching strategy, she can work with another teacher to make her ideas about the strategy explicit and come up with a solution.

Schön (1983, 1987) gave a rationale for teacher reflection. When we have learned how to do something, we can do it without having to think about it. However, sometimes this ‘knowing-in-action’ (Schön, 1983, p. 60) doesn’t suffice. Reflection is necessary when teaching dilemmas arise. Two types of reflection are (a) reflect-in-action and (b) reflection-on-action.

Reflection-in-action occurs when our thinking serves to reshape what we are doing while we are doing it. Reflection-in-action is action oriented. A teacher may experience reflection-in-action when presenting her students with a new science concept. The students may show confusion and puzzlement about the new concept. Therefore, the teacher, in the midst of her teaching, reorganizes the lesson to better explain the concept to her students.

Reflection-on-action is the ‘stop and think’ reflection when teachers think back over their teaching actions. Many times, reflection-on-action occurs after teaching a lesson. For example, upon grading her students’ laboratory assignments, a teacher may notice that many of the students incorrectly answered one section. She may use this to think back over the lab and see where the problem may have occurred. Did she explain
each section thoroughly enough? Did the lab sheet have clear enough instructions? Was all of the lab equipment working correctly and accessible to all of the students? Were the students distracted in lab? The teacher may need to review that lab section or change it the next time she performs that lab.

Bryan and Abell (1999) conducted a study to learn about a preservice teacher’s, Barbara, understanding of science teaching and learning. Her reflective process was one of the guiding methods used to facilitate interpretation of her understanding of science teaching. Barbara used Schön’s (1983, 1987) reflective notion of framing and reframing to work through the tensions in her teaching. Barbara made explicit her beliefs that science teaching was centered on the use of hands-on, inquiry-based learning. Barbara began to develop tensions in her beliefs during her analysis of a videotaped lesson of another teacher and analysis of her own teaching.

Barbara saw in the videotape and experienced in her own teaching that hands-on science teaching does not always facilitate students’ science understanding. Several times in her own teaching, her students did not understand the lesson after a hands-on lesson. Reflection on her science teaching showed Barbara ways that she could improve students’ understanding of the science content. Reflection forced Barbara to reexamine her beliefs about science teaching and change the way she was using hands-on lessons in her science classroom. The reflective process helped Barbara develop her science teaching knowledge. Bryan and Abell (1999) challenge teacher education programs to utilize reflection to promote teacher development.

Keys and Golley (1996) conducted a study of the reflective process among a mentor/mentee relationship. The participants were six classroom teachers who worked in
mentee pairs. The teaching pairs worked together in an inservice session, organized monthly plan-teach-debrief sessions, discussed their teaching after school, and used videotapes of their teaching to reflect.

The research study by Keys and Golley (1996) suggested ways to use collaboration to enhance reflection. The researchers stressed the importance of peer planning which was one of the main collaborative instruments the teachers in this research study used. The time of planning together allowed new ideas to emerge and gave the pair a more detailed and effective science lesson. The participants from Keys and Golley’s (1996) study learned how to engage their students in the science lesson; they committed to using reflection as an integral part of their teaching profession; and they used more hands-on activities than they would have without their reflective partner.

Reflection during collaborative student teaching. Lemlech and colleagues at the University of Southern California (USC) have been implementing a collaborative elementary student teaching program since the late 1980s. The preservice teachers choose their own student teaching partner and are placed into one classroom. The teacher educators require specific responsibilities for the student teaching pairs: critiquing, providing oral and written feedback, and coaching each other; having feedback sessions that included the cooperating teacher; and keeping journals. One of the main rationales for the program was for the collaboration to foster reflection.

The student teaching partners at USC reflected with each other as they drove to the schools together, talked on the telephone in the evenings, and planned their lessons together. The collaborative student teaching program also noted specific reflective behaviors. The student teaching pair ‘counseled each other about classroom
management, puzzled together about student behavior, questioned the appropriateness of selected teaching models and coached each other’s use of the models; talked about their beliefs and questioned conventional theories, and engaged in long-term planning and discussed means to integrate subject fields” (Lemlech, Hertzog, & Pensavelle, 2000, p. 8).

Later data from their program showed that the reflective behaviors learned in the student teaching program were transferred to the full-time teaching of the student teachers. In their first years of teaching, the teachers reported seeking collaborative relationships with their colleagues because they wanted and needed this ‘thinking together’ (Lemlech & Hertzog, 1998, p. 11). The teachers desired a continual improvement of their teaching practice through the help of others.

The pairing of student teachers at USC reduced the amount of dependence the student teachers had upon their cooperating teachers and encouraged more reflective, collegial relationships with their student teaching partner, cooperating teacher, and other teachers. The partnering required the student teachers to talk more about their teaching. Interestingly, the cooperating teachers ‘began to talk with the partners instead of to the partners’ (Lemlech & Hertzog, 1999, p. 28). Instead of leading the discussions as an “expert,” the cooperating teacher and student teachers began to communicate as a team where all members were colleagues and all were learning from each other. The dialogues among all of the participants enhanced reflective practice.

**Implications for my research.** While there are studies on collaborative reflection among teachers, student teachers, and K-12 students, there is a gap in the literature in secondary science student teachers. This research study adds to the literature by
examining reflective collaboration during science student teaching. Pairing student
teachers will give the novice teachers a reflective partner to work closely with as they
learn the process of science teaching. The student teachers will be able to bounce ideas
off of each other and work through problems together. The paired student teachers can
learn how to reflect as they internalize the concepts of learning to teach science.

Both reflection-on-action and reflection-in-action are important aspects of science
teaching. This research study focused more on the reflection-on-action that occurred
with the student teaching pair. I collected most of the reflection data on the student
teaching pair’s reflection-on-action as they discussed, critiqued, and came up with
solutions to their teaching actions. Most teachers begin reflecting on their actions and do
so with the help of others (internalization). The reflection then can move to their
reflecting-in-action once they are comfortable with the reflective process.
CHAPTER 3

METHODS

The methods that were used in this research study were designed to answer questions about the collaborative interactions that occurred between the paired student teachers and the reflection that they underwent. The following sections reveal how the study was planned and carried out.

Design

Qualitative Research

This research study necessitated a qualitative research design. Qualitative research takes a specific situation and uses thick, rich description to attempt to portray the viewpoints of the participants. Qualitative research is set in the natural world and primarily uses humans as instruments to collect data (Creswell, 1998; Lincoln & Guba, 1985; Marshall & Rossman, 1999; Rossman & Rallis, 1998). It is useful because it offers a way in which researchers can help people understand themselves, primarily by exposing values and resources in ways that quantitative research cannot. Qualitative researchers study humans in their natural settings because the setting shapes the participants’ actions (Marshall & Rossman, 1999).

Qualitative research “tries to understand the social world as it is from the perspective of individual experience” (Rossman & Rallis, 1998, p. 35). The researcher is trying to see the world as is and wants to produce rich description from the participants’ perspective. Qualitative research “relies on humanistic methods – face-to-face interactions, whether in the form of in-depth interviews or extended observations or some
combination” (Rossman & Rallis, 1998, p. 36). Subjectivity is used to understand the knowledge of the participants (Marshall & Rossman, 1999). The researcher is directly involved with the participants to understand their viewpoints on the research concepts.

Qualitative research promotes understanding of the meaning that people have constructed. It also involves the researcher going into the field where the situation actually takes place. Qualitative researchers spend a great deal of time in the setting to get a holistic view of the study (Creswell, 1998). They also use multiple forms of data to adequately represent the participants’ perspective (Creswell, 1998). Qualitative research allows the researcher, who is the primary data collection and analysis instrument, to use naturalistic fieldwork to construct meaning of the participants’ point of view (Merriam, 1998).

**Case Study**

Specifically, I used an interpretive case study design to conduct my research. Case studies examine single instances and give rich description (Merriam, 1998). Case studies look at a small unit of analysis in hopes of understanding the large idea (Rossman & Rallis, 1998). However, Stake (1995) points out that the primary use of the case study is to understand one specific case. Its purpose is not to explain or understand other cases. Case studies seek to answer “How” and “Why” questions (Yin, 1994). I looked at what interactions occurred within a student teaching pair, how these interactions facilitated the process of learning to teach science, and how collaboration facilitated reflection. My research sought to understand how student teachers worked collaboratively to construct meaning about science teaching. “The case study is the method of choice when the phenomenon under study is not readily distinguishable from its context” (Yin, 1993, p.
3). The information of this research study was not easily separated from the environment in which it took place.

Case studies are bounded systems by time and location (Stake, 1995). This research fits this description by being bounded by time (11 weeks of student teaching) and location (Southeast High School, more specifically, a biology/physical science classroom). Case studies use extensive, multiple sources of information (documentation, archival records, interviews, direct observations, participant observations, physical artifacts) in data collection to provide the detailed in-depth picture (Yin, 1993, 1994). In this research study, I used examples of several of these data collection methods. Case studies require considerable time describing the context or setting of the case and are known for their thick, rich description (Lincoln & Guba, 1985). Collecting data during the entire student teaching period gave me the description that was necessary to adequately illustrate how student teachers work collaboratively to develop understandings of science teaching.

Another characteristic of the case study is that the researcher many times uses a priori theories (Lincoln & Guba, 1985; Yin, 1993, 1994). Theory drives the entire case study design and is used when making decisions about method, data collection, data analysis, etc. The aforementioned theories within social constructivism are the driving, a priori theories used in this case study. Social constructivism was woven through the case study design and methods as it guided all decision-making processes. Thus, although specific aspects of collaboration emerged, I conducted the research from the view that collaboration would influence student teachers’ development.
In this case study, the case or unit of analysis was the individual student teacher. Although the study focused on collaboration and how the two student teachers worked socially, it focused on individual knowledge construction to determine how concepts that are socially negotiated are internalized by the individual.

**Site of Research and Entrée**

The two student teachers were placed in a large, rural high school in the southeast United States, Southeast High School. The high school housed approximately 1800 students from the ninth through twelfth grade. The students were mostly from upper-middle class families. More than 80% of the graduates at that time planned to attend a four-year university or college. There were 11 teachers in the science department that taught many different science courses from ninth grade physical science to twelfth grade physics.

Southeast High School was chosen for several reasons. First, it was a school in which I had already gained entrée through my role as a long-term substitute teacher in chemistry. Working closely with the teachers at Southeast High School allowed me to consider several of them as cooperating teachers for the student teaching pair. After deciding on the cooperating teacher for the proposed research study, I was able to get to know her and work closely with her. We were able to talk about the collaborative student teaching opportunity, review questions and concerns that she had, and discuss possible collaborative circumstances that would take place during the student teaching period. I was also able to introduce the student teaching pair to the cooperating teacher and have them observe her teach students before student teaching began. Another benefit of
placing the student teaching pair at Southeast High School was its convenient location to
the students, the university student teacher supervisor, and myself.

Research was facilitated through a large research university in the Southeast
United States, Southern State University. The university at that time educated
approximately 31,500 students and employed around 10,000 faculty and staff. The
College of Education at Southern State University has many departments including a
Science Education Department that at that point had 10 full-time faculty members and
facilitated the education of approximately 40 undergraduate secondary science teachers
each year.

Participants

For this research study, one student teaching pair and one cooperating teacher
were chosen. I investigated the site, Southeast High School, for a cooperating teacher to
work with the student teaching pair. I talked with the administrators of Southeast High
School first, and they felt that a specially instructed teacher would be an appropriate
choice. There was only one teacher in the science department at Southeast High School
who had completed a Teacher Support Specialist (TSS) endorsement program, Dr. Smith.

Dr. Smith was the department head of science at Southeast High School and had
been teaching high school science for 15 years. Prior to that time, she taught five years
of college science. Dr. Smith has a Ph. D. in Molecular Genetics and has taught a wide
variety of high school science subjects. Her education in the field of science was
reflected in the way she approached high school teaching. She was very organized and
structured in the way she handled her biology classroom. She had the classroom
arranged in a very systematic manner. The student desks were in straight rows; her
bulletin boards and posters were arranged around the room in a very well organized fashion; and her class schedule was meticulously planned out and structured.

I approached Dr. Smith about being the cooperating teacher to a student teaching pair. She willingly agreed and was optimistic about the opportunity to be a part of this collaborative student teaching placement. Dr. Smith had served as a cooperating teacher in the past but had never had a student teaching pair. Dr. Smith was open to the idea of educational research and the improvement of the student teaching process. As the study progressed, it became apparent that she would not allow Brittany and Diane to deviate far from her structured plans. Therefore, her participation in the study led to limitations in the student teachers’ ability to try various teaching strategies. The following section on the contexts of the field experience further explains these limitations.

To choose the student teaching pairs, I used purposeful sampling (Patton, 1990). The 11 students enrolled in student teaching during the Fall Semester, 2000 (the semester in which I collected data) were previously enrolled in a science practicum course. The practicum course paired most of the preservice students for two three-week practicum experiences.

Throughout the practicum course, I got to know the preservice teachers, observed some of them teaching, and interviewed many of them about their teaching experience. I also talked with the entire practicum class about my dissertation topic of pairing student teachers. The students had the opportunity to volunteer to be paired. Those students who showed an interest in being paired were interviewed in-depth about what peers they would work well with and their concerns and questions about a paired student teaching placement.
There were 11 preservice teachers in the practicum class. All of the preservice teachers agreed for me to observe and interview them about their pairing during the practicum. I gave the practicum students a questionnaire about their student teaching requests. The questions focused on where they would like to student teach, what level and science subject they wanted to be assigned, and if they would be willing to be paired during their student teaching. I also talked with the two practicum course professors about the students who would work well together due to personality, work habit, and compatibility with their peers.

Based on the questionnaires, I interviewed seven student teachers about the possibility of being paired during student teaching. Taking into consideration the practicum students’ willingness to be paired during student teaching, compatibility with others who wanted to be paired, and their request of grade level, science subject, and location to student teach, two student teachers, Brittany and Diane, were chosen to participate in the study. I talked with both Brittany and Diane to make sure they were in agreement regarding being paired with each other, the site that had already been chosen, and the classes they would be teaching. Both agreed to be a part of this collaborative student teaching placement.

Brittany is a White female in her early 20s. She graduated from a small private high school and has a Bachelor’s of Science degree in Biology. At Southern State University, she was working on her Master’s degree of Science Education. During the practicum course, Brittany was paired for three of the six-week field experience with someone other than Diane. Diane is also a White female in her early 20s. She graduated from a small public high school and was working on her Bachelor’s of Science degree in
Science Education at Southern State University. Diane was paired for the entire six weeks during her field experience in the practicum course with a practicum teacher other than Brittany.

Dr. Smith mentored Brittany and Diane for the entire 11 weeks of student teaching. Brittany and Diane taught two 10th grade advanced Biology I classes and one 9th grade general physical science class. Dr. Smith also taught an Advanced Biology II in which the students may earn college credit. Dr. Smith, Brittany, and Diane agreed that this class should be taught by Dr. Smith alone, so it was arranged for them to teach physical science under another teacher in the department, Mr. Fulton. Mr. Fulton has a Bachelor’s degree in Landscape Architecture and a Master’s degree in Education. He has been teaching high school for 10 years. While Mr. Fulton mentored their teaching during this one class, Dr. Smith was their supervisor while student teaching.

Brittany and Diane’s student teaching was supervised by Southern State University. All student teachers at Southern State University were required to complete several basic requirements during the student teaching period. Brittany and Diane were given a pacing guide at the beginning of their student teaching that was arranged in blocks of time ranging from one to three weeks. Each block of time listed tasks that the student teachers should be able to complete during that time period. The task schedule could be adapted slightly to fit the individual student teacher’s circumstance. The student teachers as well as the cooperating teacher and university supervisor kept up with which tasks had been completed and which tasks remained for the student teachers to complete.

Brittany and Diane were supervised by a university professor who observed their teaching three times and gave written and oral comments and feedback on their teaching.
These observations occurred during each of the two biology classes and the physical science class. For each of the observations, Brittany and Diane were required to furnish a formal, detailed lesson plan. For the rest of their student teaching period, they were required to keep informal lesson plans each week. The university supervisor also gave a midterm evaluation as well as a final evaluation at the end of the student teaching period.

Concurrent with Brittany and Diane’s student teaching was a reflection class that met once a week. The reflection class was designed to enhance the student teaching experience by providing opportunities for the student teachers to reflect on their teaching. Brittany and Diane completed many assignments in the reflection class that included critiquing and reflecting on a videotape of their teaching, reflective metaphors that described their view of teaching, and whole class reflections about specific teaching dilemmas. All of the requirements for student teaching at Southern State University were designed to allow student teachers to have the best experience possible.

I protected the confidentiality of the participants. The tapes from the interviews were erased after the study was completed, and pseudonyms were used in all reports that were created from the data. The participants’ names were also removed from any written document that was used.

**Contexts of the Field Experience**

Brittany and Diane encountered several constraints in their teaching-learning environment over the course of their student teaching. Their cooperating teacher, Dr. Smith, has been teaching for several years, is the head of Southeast High School’s science department, and holds a Ph. D. in molecular genetics. Therefore, she was very set in the way that she taught her science classroom. While she invited Brittany and
Diane to student teach in her classroom and expressed an excitement about seeing new ideas and activities, several constraints were placed upon Brittany and Diane’s teaching arrangement.

Dr. Smith had a very structured classroom environment. Every day, the students entered with a bellwork assignment awaiting them. The students were to immediately sit down and begin the bellwork assignment which consisted of getting out their material from the previous day, reviewing their notes, answering questions in their textbook, etc. The bellwork was designed to eliminate much of the wasted time at the beginning of the class period and get the students instantly on task. After several minutes of working on the bellwork, Dr. Smith explained the day’s agenda and proceeded with the lesson. Brittany and Diane felt obligated to continue with this tradition.

There was a compelling need in Dr. Smith’s classroom to cover the state-mandated curriculum. Dr. Smith’s first priority was to make sure that the students were taught the science content that was in the curriculum and on the state’s graduation test. This placed severe time constraints on the freedom Brittany and Diane had to practice various science teaching activities. Also, due to Dr. Smith’s scheduling of the four lab rooms that were shared by all of the science teachers, Brittany and Diane only had one day per week, Tuesday, that they could do a lab experiment in the lab room.

Brittany and Diane both indicated their perception that science learning was inquiry based. Both student teachers entered their science classroom wanting to introduce their students to the many science activities that are a part of science learning. “I think there’s a lot that we both want to do in the classroom that we can’t do. We would both like to be more creative in the classroom, but time doesn’t allow it” (Brittany,
interview, 9/8, p. 2). Brittany and Diane spent much of their co-planning discussing how much time each activity would take.

Because Brittany and Diane were so pushed not to waste time, they felt forced into giving far too many notes to their students. For each chapter, Dr. Smith gave Brittany and Diane her folder of plans for the student teachers to follow. Brittany and Diane felt restricted from deviating too far from Dr. Smith’s plans. Brittany told in her interview on 9/8 that we give too many notes. That’s something we’ve been pulled into (p. 3). Later in the same interview, Brittany explained how the amount of notes they were giving took some of the skill out of teaching. I hate giving so many notes. You can just stand there and read it off. You don’t really even have to know the material (p. 7). When asked if there was anything in her teaching that contradicts with her understanding of science teaching, Brittany responded,

Lots of aspects of my teaching contradict my understanding about science teaching. I think we give entirely too many notes, but I feel like our cooperating teachers are always breathing down our backs reminding us that we’re behind, and that they [the students] have to pass the graduation test. So, as long as it’s not “technically” my classroom, I feel like we’re suckered into giving notes to cover the necessary material (interview, 9/20, p. 4).

Diane further explained that we’re in the too much content/not enough time situation. I think it’s better when you go into smaller quantities and more quality. We have to cover so much information in the biology class. You’re missing the big concepts because we’re trying to teach so many little details. I don’t agree with that (interview, 9/8, p. 6). In co-planning session, 9/10, Diane showed her frustration in the amount of time she had to cover an entire chapter on photosynthesis.

We have to cram this into four days, and we have to cover all that she talked about earlier? I don’t think they should know so much about this. We should introduce it to them, but they shouldn’t have to know all that is on here. I think
we should simplify photosynthesis. I would rather the students walk away with a good understanding of the overview of how it works than to throw all of this information that confuses them. I think we’re covering too much in too little detail (p. 13).

Brittany and Diane also felt limited in the types of tests they could administer. Both of their cooperating teachers administered scantron tests to their science students. Brittany and Diane both admitted their frustration with scantron tests. Because of their issue with scantron tests, Brittany’s ‘burning question’ to research for her reflection class focused on assessment. In her interview on 9/20, Brittany explained why she dislikes scantron tests.

I hate scantron tests. They may be convenient to grade, but I don’t think they allow students to show us what they know. In making up the midterm, I would like to ask questions that help them pull everything together to see the big picture. That would be a nice alternative to multiple choice. When I mentioned breaking away from scantron, one of our cooperating teachers smirked at me. I think the only positive thing about it is that it helps cut back on the whole ‘Xerox’ dilemma - not as many copies to make when you use a class set (p. 4).

Diane’s opinion of scantron tests resonated with Brittany’s. ‘Scantron tests don’t validate what students know about science. Scantron tests structure the student responses in a way that doesn’t allow for individual interpretation or partial credit. Yet, we give them over and over. I feel like I’m cheating the students and myself. What is going to happen when these kids get to college and they don’t know how to take essay tests?’ (interview, 9/20, p. 5).

While they were opposed to giving scantron tests, neither student teacher wanted to drastically change their cooperating teachers’ classroom. Brittany and Diane knew that both Dr. Smith and Mr. Fulton would go back to their classroom routines once the student teachers left. ‘We both say we want to get away from scantron tests yet it’s
difficult because we don’t want to disturb their whole pattern that they teacher starts the first weeks of school” (Brittany, interview, 9/8, p. 2).

While Brittany and Diane felt limited in the amount of time they had to cover the science content, the way they were presenting too many notes, and the types of tests they had to administer, positives came out of the situation. The student teachers learned how they wanted to run their classroom. Brittany and Diane said that their student teaching taught them good things they wanted to implement in their classroom, but they also learned some things they wanted to avoid. Both felt that the limitations that were placed on them helped them see what they didn’t want to happen in their classroom.

Teaching Schedule

Dr. Smith felt it was important to have a schedule of Brittany and Diane’s teaching arrangement for the student teaching period. Therefore, she came up with a projected teaching schedule for the student teachers to follow (see Appendix A). The teaching schedule allowed the student teachers to engage in a variety of teaching arrangements.

Brittany and Diane began their student teaching by observing their cooperating teachers for two weeks (weeks one and two). After two weeks, they began taking over the biology classes with paired teaching and paired planning. During this time, Brittany and Diane planned the lessons together and taught them together. Both student teachers were involved in all aspects of both biology classes. After one week (week three) of team teaching and team planning the biology classes, Brittany and Diane picked up the physical science class. For one week (week four), the student teachers were pair teaching and pair planning for all of their classes.
During week five, Brittany and Diane continued to pair plan for all of the classes and they team taught physical science. However, one student teacher individually taught one of the biology classes while the other taught the second biology class. The student teachers then individually taught the separate classes beginning in week six. Brittany taught biology while Diane was teaching physical science, and then, in week seven, the two switched classes. During this time, they were teaching and planning individually.

In week eight, Brittany began teaching all of the classes. She individually planned and taught physical science and both biology classes. Diane used this time to observe and critique Brittany and help her work through some teaching dilemmas. Diane also observed other teachers in the school in science and other subjects. Diane began teaching all of the classes in week 9 while Brittany observed her and other teachers. By week 10, both teachers began pair planning and pair teaching biology but dropped the physical science class. The student teachers ended their student teaching by dropping the biology and doing some additional observations of the science teachers.

**Data Collection**

Data can be defined as the pieces of information that are collected through a research design. Data in qualitative research are mostly expressed as words. The qualitative researcher, being the main instrument for data collection, utilizes various data collection methods. I used several types of data collection methods including interviews, observations, audiotapes from co-planning sessions, and documents.

Interviews, observations, and co-planning sessions were all significant sources of data for both research questions. I began identifying the types of collaborative interactions that occurred between the student teachers by initially observing the student
teachers. The observations were then used to compose interview questions for Brittany and Diane. I also used the audiotapes from the co-planning sessions to create interview questions for the student teachers.

Interviews were face-to-face conversations with the participants (LeCompte & Preissle, 1993) about specific aspects of the participants’ understanding. Interviews allowed me to not only obtain important information but also to pick up on the body language and facial expressions of the participants. All interviews were tape recorded and transcribed. Appendix B lists the interview questions. The questions were guiding questions and changed according to the student teachers’ responses.

Another data collection method used to answer the research questions was observation. Observations were advantageous for several reasons. I was able to personally grasp a notion of what was going on with the pairing of the student teachers. This allowed me to see things that the participants may not have seen or may not have wanted to talk about. Also, by conducting observations, I received a first-hand account of the situation instead of relying solely on the participants’ perspective. Observations gave me personal data about the experience (Lincoln & Guba, 1985; Patton, 1990). Observations provided insight unto the reflective practices of the paired student teachers. I was able to see results from Brittany and Diane’s reflection during their classroom teaching.

My role during the observations was that of a nonparticipant. Merriam (1998) calls this “observer as participant” (p. 101) in that I was not hidden from the participants or their students. I was as removed as possible so that the class could run as normal. LeCompte and Preissle (1993) state, “nonparticipant observation is used when
researchers require comprehensive, detailed, and representative accounts of individuals’ behaviors” (p. 206).

Field notes were the written accounts of my observations. I used field notes to record interpretations from the observations. I looked for and recorded information pertinent to the collaboration of student teachers such as conversations, attitudes, and processes that were used in the student teachers’ science teaching. Science teaching activities also helped reveal the student teachers’ reflective behaviors that occurred.

From the field notes, I constructed several vignettes to help explain the data. I used the observations to recreate some of the stories that occurred during Brittany and Diane’s teaching. These vignettes were useful to help me and the reader jump into the classroom and experience the situation as if present.

Audiotapes of the student teachers’ co-planning sessions were used to recognize Brittany and Diane’s collaborative interactions. The audiotapes of their co-planning sessions were perhaps the most significant data collection method used to reveal Brittany and Diane’s reflective interactions. During their co-planning sessions, Brittany and Diane reflected about their science teaching. These reflections were also used to create interview questions for the student teachers. The student teachers taped all of their formal planning sessions ending up with five audiotaped sessions. All five of the co-planning sessions occurred at the participants’ home without the assistance of Dr. Smith, their cooperating teacher. The audiotapes were transcribed, and I analyzed them for information about their collaborative and reflective interactions.

Finally, the documents I collected to answer the research questions included texts used during labs and science teaching activities and the student teachers’ lesson plans. I
collected the documents that the student teachers passed out in class. Such documents were science handouts such as concept maps, lab worksheets, and guided notes; instructions for class activities; questions for students to answer; and assessments of the science activities. I also collected some of the documents Brittany and Diane prepared for their reflection class at Southern State University. While document analysis was intended to be an important data analysis tool, the documents didn’t add much to the data analysis. There was little information in the documents on the student teachers’ collaboration or on their reflection.

LeCompte and Preissle (1993) point out that one of the first steps in data analysis is to ‘relocate the original research question’ (p. 235). Since data were analyzed throughout the entire student teaching period, I continually kept the case study focused on the original purpose of the study. It was obvious from the nature of the study, paired student teaching, that many collaborative and reflective interactions emerged.

I began collecting data by observing the student teachers teaching. There were a total of 12 observations during the eleven weeks of student teaching. The observations ranged from observing two class periods (three hours) to observing the entire teaching day (seven hours). In the midst of the observations, two face-to-face interviews and one email interview were conducted with each student teacher. A final interview was conducted via email and only Diane responded. Five co-planning sessions were audiotaped and transcribed throughout the student teaching.

**Data Analysis**

Data analysis and the conclusions that are made from analysis are central to making a study important and meaningful to the researcher and to others. I analyzed the
data in the midst of data collection (Bogdan & Biklen, 1998; Glaser & Strauss, 1967; Glesne, 1999; Merriam, 1998; Miles & Huberman, 1994; Schumacher & McMillan, 1993) because each data collection activity informed and guided the next. I read the interview transcripts, observation field notes, co-planning transcripts, and documents throughout the case study so that I could shape my subsequent data collection around the results. After data collection ended, I analyzed the data by reading through the data to get a feeling for the complete story (Bogdan & Biklen, 1998; Creswell, 1998; LeCompte & Preissle, 1993; Schumacher & McMillan, 1993). Reading through the complete data allowed me to get reacquainted with the data and to check for any missing parts of the data.

After reading through the data, I began initial segmenting and coding of the data. I broke the data into segments, which are the smallest forms of data that are still comprehensible ideas (Schumacher & McMillan, 1993). In my research, the segments were phrases, clauses, a sentence, or a few sentences. I looked at all of the observations first and made initial codes of the data. The purpose of the initial codes was to organize and group related data segments. The initial codes included both descriptive and interpretive codes of the data.

I then coded the data from the interviews and finally from the co-planning sessions. Initial codes were made for the interviews and co-planning sessions. The initial codes from each of the data sources were compared to the initial codes from other data sources according to their similarities and differences. A codebook was kept which listed the codes and abbreviations of the codes (Bogdan & Biklen, 1998; Glesne, 1999).
After the data from the observations, interviews, and co-planning sessions had been initially coded, I took the most important initial codes that occurred in the data repeatedly and analyzed them further. For example, the initial code “division of teaching responsibilities” appeared over and over in all three data sources. To begin closer analysis of the “division of responsibilities” code, I looked over the data from all three data sources a second time. Each time a data segment belonged to this code, I wrote the entire segment in my codebook. Below are some examples of these data segments that fell under this code.

- Writing notes on the overhead
- Teaching content
- Answering students questions
- Brittany types notes while Diane worked on worksheets for class
- Preparing for lab

Each data segment that fit into the initial code “division of responsibilities” was written out for observations, interviews, and co-planning sessions.

I reviewed the initial codes according to my conceptualization of the meaning of the data and modified them into my conceptual categories. The categories primarily emerged from the data but were informed by the research questions, the study’s research instrument such as an interview guide, and my prior knowledge (Bogdan & Biklen, 1998; Schumacher & McMillan, 1993). As Miles and Huberman (1994) point out, categorizing the coded data allows qualitative researchers the ability to understand the phenomena better by grouping and conceptualizing the data.

After the data segments for each category were written out, I looked over each of the data segments and began separating them. I looked at the data to see how each of the segments was similar and different. Secondary and tertiary codes for each category
emerged from the data segments. I refer to these as major codes and subsequent codes, respectively. The major codes were the most significant codes that fell under each category. The major codes were then divided into subsequent codes. The major and subsequent codes helped me organize the data into each category. Appendix C contains the complete coding scheme.

During the segmenting and coding of my data, Glaser and Strauss’ (1967) constant comparative method was used. As individual data segments were formed, they were compared and contrasted with other data segments. I looked for segments that were related among single data sets and across the data sets. Comparing and contrasting helped me to create the codes and categories that ultimately became the research study’s findings.

Finally, I looked for similarities and differences between the categories to form the patterns that are the ultimate purpose of qualitative research. Patterns represent the relationship among the categories of coded data – “how the categories affect and are affected by the other categories” (Schumacher & McMillan, 1993, p. 495). The patterns are the basis for reporting the findings. Two patterns came out of the data, collaborative interactions and collaborative reflection.

**Trustworthiness**

All research must be trustworthy and honest. Researchers must be careful to ensure that their data collection and analysis have been conducted in such a way as to produce truthful results. Credibility occurs when the researcher ensures that the findings are representative of the original data (Lincoln & Guba, 1985; Merriam, 1998). A researcher ensures that a study is credible using several methods. Triangulation is one of
the most common techniques used to confirm research in qualitative case studies. Triangulation involves using multiple sources of data to confirm the findings. I collected data from interviews, observations, co-planning sessions and documents.

Credibility is also established when researchers commit to long-term study in the field (Merriam, 1998). Long-term engagement allowed me to obtain as much information about the situation as possible. I was able to establish trust with the participants that led to more in-depth data from them. I also used member checks to ensure credibility. Lincoln and Guba (1985) assign member checking as the “most crucial technique for establishing credibility” (p. 314). To conduct a member check, I asked my participants to read the results I produced to make sure it was representative of what they intended to report.

Dependability refers to the ability of the reader to generalize the findings of a qualitative study. The ability to generalize findings is important to many research studies. Many researchers conduct studies so they can make assumptions about other situations. However, generalizability is not the important basis in qualitative case study research. Case studies rarely meet the requirements that are necessary to generalize to other findings (Lancy, 1993; Lincoln & Guba, 1985; Stake, 1995; Yin, 1993, 1994). The readers of case studies already have an interest in the subject. Therefore, case study audiences make generalizations to their individual interests and areas of expertise (Lincoln & Guba, 1985; Stake, 1995). Lincoln and Guba (1985) point out that qualitative researchers have “the responsibility to provide the data base that makes transferability judgments possible on the part of potential appliers” (p. 316).
Instead of concentrating on the ability to repeat their research, qualitative researchers want to make sure the results are “consistent and dependable” (Merriam, 1998, p. 206). Are the results of the research study reliable according to the data that were collected? Several methods were used to help ensure dependability. Triangulation was used to confirm dependability (Lincoln & Guba, 1985; Merriam, 1998; Miles & Huberman, 1994). I also kept an audit trail, which was a record of the step-by-step process I followed during the research study. I made sure the research questions were clear, that the research design fit the research questions, and that my role in the research study was clear (Miles & Huberman, 1994).

Perhaps the most useful technique to ensure dependability of the research study is to have an outside person read through the data collection and analysis procedures and results (Lincoln & Guba, 1985; Miles & Huberman, 1994). Once the data were collected, a reliability check was designed to ensure dependability of coding. Two outside readers, one a doctoral student in science education and one holding a M. Ed., performed reliability checks. Transcripts from one observation, two interviews, and one co-planning session were given to each reader. The readers independently coded each of the data sets. The readers only created initial codes of each data set. I decided to check the reliability of the initial codes so that I could make sure the foundation of my data analysis was reliable.

Of the 18 initial codes from my observations, one reader matched 15 of them while the other reader matched 16. Both readers had one initial code that weren’t the same as my codes. I had 10 initial codes for the interviews of which nine were congruent with both outside readers. One reader included one additional code for the interview data
set. There were nine initial codes from my set of co-planning sessions. One reader matched seven of the codes with one additional code. The other reader matched eight of the codes from the co-planning sessions.

1 All names have been changed to provide confidentiality.
CHAPTER 4

RESULTS

This research study examined two aspects of a paired student teaching placement: the collaborative interactions that took place between two paired student teachers and the role of reflection in the learning to teach process for paired student teachers. The data to explain each research question are presented below.

Description of Collaborative Interactions

Overview

The research questions utilized the three data sources described in the methods section – interviews, observations, and co-planning sessions. The data sources supported one another in showing many collaborative interactions the student teachers were involved in during their student teaching. However, two major collaborative interactions emerged as Brittany and Diane worked together in their student teaching: division of teaching responsibilities and giving two explanations of the science content.

Interaction One – Division of teaching responsibilities

One of the primary interactions between Brittany and Diane was the division of their teaching responsibilities in the biology and physical science classes. I concentrated on what science teaching concepts the student teachers divided, where the decisions about the division were made, and the approaches Brittany and Diane used to divide the science teaching concepts.
Responsibilities being divided. Throughout their student teaching, Brittany and Diane divided many of their science teaching responsibilities. The responsibilities that Brittany and Diane divided fell into three areas: administrative issues, science content preparation, and science teaching.

Many issues had to be dealt with besides actual science teaching. Throughout the student teaching period, Brittany and Diane encountered many administrative issues - issues that dealt with the everyday managerial tasks that were necessary to run a science classroom. During each of the 12 observations, I observed Brittany and Diane share administrative responsibilities such as taking attendance, grading papers and recording grades, and getting worksheets and homework papers ready for class. They assisted each other in disciplining students both verbally and nonverbally, changing overheads, and watching for students’ knowledge understanding while the other was teaching. Brittany told me “it’s really helpful. One of us can do the attendance sheet while the other one is setting up what we’re going to do. We can split up and sit in different places [during a test] and watch the kids that way” (interview, 9/8, p. 5).

Brittany and Diane also divided the science content preparation. In the beginning, they divided the preparation as they worked together to plan the science lessons. For example, when Brittany and Diane taught cell parts, Brittany typed a student copy of their notes while Diane worked on an activity worksheet (observation, 8/29). Diane made a transparency of content from their notes, and Brittany created a concept map of prokaryote versus eukaryote cells (observation, 8/29). While working on notes, the student teachers divided the responsibility of searching for information on the Internet, other science texts, and science journals (co-planning session, 8/27).
Along with dividing administrative issues and science content preparation, Brittany and Diane shared the responsibility of teaching. Their team teaching consisted of giving notes together, helping each other answer students’ questions, and conducting lab and class activities together. Brittany and Diane also assisted each other in giving assignments, providing directions, and doing review exercises with the students. Diane reported in her interview on 9/8,

I think having a teaching partner helps me because I have time to slow down and breathe and think about what we’re teaching. It helps when you have two doing it. You have time to stop and think and are more worried about the content you are teaching as opposed to punching holes or stuff that will cut down your teaching time. Also, I feel as if the students benefit more if we are team teaching. This way, they are getting the lesson from two perspectives (p. 3).

Diane’s quote revealed that she was less overwhelmed by the “busyness” of teaching and spent more time concentrating on the content she was teaching. Diane felt she had more opportunities to think about the science lesson instead of worrying about simple teaching tasks that had to be done.

Brittany pointed out in her interview on 10/12, “It’s very good with the collaboration if one is listening while the other is teaching. There have been times when people have asked one of us questions and we don’t understand what they’re asking. The other one can interpret what the student is saying” (p. 6). To me, Brittany revealed that sharing the responsibility of teaching was advantageous from their students’ point of view. Instead of the teacher not understanding their questions, paired student teaching provided another viewpoint from which uncertain comments were clarified.

Where teaching responsibilities were divided, The decisions of what to divide came about as the student teachers discussed and planned their science teaching. Brittany and Diane made most of the decisions about the division of administrative issues during
planning time at the school or at home. Occasionally, Brittany and Diane dealt with administrative issues during teaching such as disciplining students, passing out papers, or taking attendance. Brittany and Diane made all of the decisions about the division of science content preparation during planning time. On the other hand, they divided the science teaching responsibilities during actual teaching. These were decisions about explaining specific science concepts, walking around answering questions in lab, and giving instructions for a class activity. Dr. Smith was not involved in any of the divisions of the science teaching tasks.

Two approaches for dividing teaching responsibilities. Throughout their student teaching, Brittany and Diane divided the responsibilities of teaching. The divisions occurred in one of two ways: the student teachers either worked separately on the same science teaching task or separately on different science teaching tasks. As described above, Brittany and Diane’s division of science teaching including administrative issues, science content preparation, and science instruction.

Brittany and Diane divided the administrative tasks by working more on different tasks than on the same one. For instance, Brittany prepared class worksheets in the front of the classroom while Diane took up tests from the students (observation, 9/7). Diane took attendance in class while Brittany passed out homework (observation, 9/5). However, a few times they worked on the same task. For example, Brittany and Diane graded the same classes’ papers together (observation, 8/30) and helped each other prepare for a catalyst lab by grinding up chicken liver together (observation, 9/12).

Science content preparation was also divided similarly with the student teachers working more on different tasks than on the same one. The student teachers divided the
preparation of class activities to do at home such as cutting out strips of paper for an activity (observation, 10/3) or typing up an activity worksheet (co-planning session, 9/4). Brittany made up a quiz while Diane searched for an explanation of the sodium-potassium pump on the laser disc (observation, 9/12). Occasionally, Brittany and Diane worked together on the same science activity. In each of their five co-planning sessions, the student teachers made out notes together. They discussed the science content and prepared for class discussion. Toward the end of their student teaching, Brittany and Diane planned together but taught the classes individually. Therefore, they worked together on the same content preparation but separately on the science teaching.

Finally, Brittany and Diane divided science instruction. Most of the time, the student teachers taught the same concepts as they worked collaboratively during their paired teaching. Brittany and Diane would both be in the front of the class giving explanations, answering questions, and showing examples of the same concept. The students were able to get two explanations about the same concept. Sometimes, Brittany and Diane approached science instruction in a complementary fashion as they divided instruction. For example, Brittany and Diane walked around answering different questions from their students (observation, 9/12). Also, Brittany explained a concept to an individual student while Diane taught another lesson to the rest of the class (observation, 9/29). At the end of the semester, Brittany and Diane taught individually. At this time, Brittany and Diane worked completely on different tasks.

Interaction Two – Giving two explanations

During the course of their student teaching, Brittany and Diane had many opportunities to teach together. Their paired teaching occurred as they taught the whole
class together, as they walked around and helped the students in lab, and as they answered students’ questions during test reviews. Thus, the student teachers helped each other clarify science content as they presented two explanations during teaching. Giving two explanations took place when Brittany and Diane offered their own individual understanding of the same science concept. Brittany and Diane presented two explanations in four types of interactions: explaining content, giving directions, answering questions, and disciplining students.

**Explaining content.** Brittany and Diane began their student teaching with paired teaching and planning. During this time, the student teachers had many occasions to assist each other in explaining science content to their students. Sometimes, one student teacher explained a science topic without the help of the other. However, most of the time, Brittany and Diane together taught science to their students providing two explanations on the same science concept. For example, Brittany introduced the terms homogeneous and heterogeneous to their physical science students. She defined the terms and showed examples of homogeneous and heterogeneous mixtures in their book. Diane then explained how the milk we drink out of the store is homogeneous. Diane explained how she once worked on a farm and milked cows. The cow milk separated thus forming a heterogeneous mixture (observation, 9/5). Brittany told me, “we are able to feed off of each other’s ideas during lectures and discussions just as we do in planning, so we can usually help each other explain things to the class” (interview, 9/20, p. 2).

**Giving directions.** The student teachers also helped each other explain directions to their students. At the beginning of the semester, Brittany and Diane went over the class rules together. They explained how to take notes and gave the students some study
tips for taking quizzes and tests (observation, 8/28). The student teachers also helped each other give lab directions. They observed that their science students needed guidance when conducting science experiments so it helped to have two explanations for the lab activities. Brittany and Diane helped each other explain directions for tests and homework assignments. For instance, at the conclusion of one of the biology classes, Brittany told the students to look over the material in the book to study for their test. Diane reinforced this idea and told the students to look through the book because the information would be on the test (observation, 9/12).

**Answering questions.** Brittany and Diane were the most help to each other in answering their students’ questions. Brittany explained, “While my partner is teaching, I can sometimes interject to try and answer a question. There have been instances in which she [Diane] has not understood the students’ questions, and I have been able to reword them for her to answer” (interview, 9/20, p. 5). The student teachers helped each other answer questions about class content, lab and classroom activities, and quizzes and tests. Once, a student asked for the definition of an organelle. Brittany told her that all organelles have membranes, and Diane gave the analogy of our skin being like an organelle’s membrane (observation, 8/28). Another time, a student asked why you couldn’t see live organisms when using an electron microscope. Diane answered that the electrons were passed through the organism inside of a vacuum. Brittany then explained that the organisms were also coated with metal that killed the organism (observation, 8/29).

**Disciplining students.** Finally, Brittany and Diane gave two explanations when disciplining students. The student teachers depended on each other and had many
discussions about how to discipline their students. Disciplining students was a sensitive area in which Brittany and Diane were both tested. It was helpful that Brittany and Diane had each other to help them deal with this area of learning to teach.

The student teachers had to talk with their students on several occasions about cheating. Brittany and Diane saw one student trying to cheat on a homework assignment (observation, 8/29). So they addressed the entire class the next day about the consequences of cheating. Diane went over their course policy on cheating, and Brittany reiterated the importance of this rule. They explained that any cheating would be handled with the strictest consequence possible (observation, 8/30). In another instance, a biology student had the habit of being very obnoxious in class and always brought up topics that were off the subject. One particular day he was disrupting class after being repeatedly told to stop by Brittany, Diane, and Dr. Smith. Finally while Diane was teaching, Brittany took the student in the hall and reprimanded him (observation, 10/3).

The Impact of Collaborative Reflection in Paired Student Teaching

Overview and Context for Reflection

Reflection was a focus of the learning to teach process for Brittany and Diane. The student teachers reflected every day on their students, their lesson, and the science content as well as on management issues of learning to teach science. While individual reflection was an important part of Brittany and Diane’s teaching development, most of their reflection was initiated, promoted, and resolved together as science teacher collaborators.

The context for Brittany and Diane’s reflection varied throughout their student teaching. They had opportunities for reflection all day and utilized many of these
opportunities. Brittany and Diane were constantly reflecting on their students, the science lesson, and the science content. Both of the student teachers reported that they reflected together in the car every day as they rode to and from school together and to their university classes together at night. Brittany and Diane used this time to reflect over the day’s lesson and get ready for the next day’s events.

Reflection also occurred during Brittany and Diane’s co-planning sessions. Over the course of their student teaching, Brittany and Diane had five co-planning meetings for their paired teaching. During each of these meetings, the student teachers reflected on all aspects of science teaching. Reflection also occurred at school. Brittany and Diane reflected before and after school as well as in between their classes. Many times, they adjusted the lesson based on their reflection. Brittany and Diane’s reflected during their science teaching as well. They engaged in reflection-in-action (Schön, 1987) when they modified their teaching based on their students’ reaction and/or performance. The modifications that took place based on their students’ reactions/performances came during the moments of teaching.

The final context for reflection took place during their partner’s performance and peer critique. During individual teaching, Brittany and Diane watched for the first time their partner’s teaching of a particular lesson. This made Brittany and Diane reflect on what they would do differently or what they would do the same. Subsequently, the student teachers critiqued their partner, which helped their partner to reflect on herself.

Participants’ View of Reflection

In this research study, I viewed reflection as a process teachers go through to analyze and refine their teaching practices. To me, reflection entails using knowledge
from past experiences to transform present and future teaching actions. Reflection involves looking at one’s actions and modifying them in order to improve their teaching, resolve dilemmas that arise, and expand their ideas about teaching and learning.

In her interview on 10/12, Brittany talked about her view of reflection.

To me, reflection is when something pops into your mind. You have to put it off to the side for a minute and go back and think about it later. That’s really what’s going to kick off my whole reflection process. I have to remember what was happening while I’m actually up there teaching. That’s a good way that I reflect on my own teaching (p. 2).

In the above quote, Brittany described her view of reflection-on-action (Schön, 1987) and how she began her reflective process. A situation arose in her teaching that interrupted her train of thought. She made a mental note of the situation for later reflection. In each of her interviews, Brittany talked about how she and Diane discussed their teaching after class. They discussed the progress of their students, the success of the lesson based on their students’ responses, and what teaching practices they needed to improve on and change.

Brittany also talked about how she underwent reflection-in-action (Schön, 1987). In the quote below, Brittany explained how she changed her teaching in the midst of the lesson.

I may reflect in the middle of class when I’m trying to read the expression on everyone’s face out in the class. I can see that the students weren’t getting a lesson last week on protein synthesis and I reflected on what I could do differently. . . . So, I made a diagram of the entire process. They could see the big picture laid out together. I thought that would help instead of having individual processes. You need to see where you start and where you finish. A couple of them said it helped them see the big picture (interview, 10/12, p. 2).

Brittany’s notion of reflection described how she both reflected on her teaching actions (reflection-on-action) and during teaching itself (reflection-in-action). She expressed a
somewhat elaborate view of reflection despite her limited experience in the science classroom.

While Diane never directly expressed her idea of reflection, several instances in her interviews and co-planning sessions suggested that she shared a similar notion of reflection-on-action as Brittany. In her interview on 9/8, she described reflecting on the ineffective lesson in their physical science classroom. Diane noticed right away that she and Brittany were unable to keep their students’ attention by giving notes for too long. She talked about looking back on their teaching, evaluating their practice, and seeking changes to their lesson presentation. Diane also described how she and Brittany reflect on their students’ behavior (interview, 10/5). After their classes, they discussed many of their students and how to handle specific circumstances that arose.

The data on Brittany and Diane’s reflection is divided into three parts: the triggers that brought about reflection, evidence of Brittany and Diane’s growth through reflection, and mechanisms of reflection. The sections below describe the collaborative reflection that took place during the student teaching period.

**Triggers for Reflection**

Several instances triggered reflection on Brittany and Diane’s teaching throughout their student teaching. Brittany and Diane ran into dilemmas in their classroom that sparked reflection. The student teachers also used their students’ feedback to reflect on their teaching.

**Dilemmas.** Brittany and Diane’s reflection was occasionally brought about by dilemmas that occurred in their science teaching. The two dilemmas that caused the most reflection were presentation of the biology notes and presentation of the physical science
notes. While Brittany and Diane reflected on how to present notes in both classes, the dilemmas were different and were dealt with in different ways. The following discussion is explained in terms of the biology and physical science notes dilemma.

Dr. Smith, their cooperating teacher, had been using guided notes for years in her biology classroom. The guided notes were an outline of the teacher’s notes with words left out systematically. The students had to fill in the missing word as the notes were being explained. However, in their discussions, Brittany and Diane thought that guided notes made the biology students very lazy during class. The students did not pay attention to the lesson; they would just listen for the word to fill in the blank.

The lack of success Brittany and Diane saw with the guided notes perturbed them mainly because as students themselves, they preferred guided notes. Diane mentioned in the co-planning session on 9/10 that ‘I’ve had a teacher to use guided notes, and I felt I could listen more” (p. 4). Also, Brittany and Diane thought that the guided notes organized the science content and helped their students study. Even with the few advantages to using guided notes, Brittany and Diane felt strongly that the biology students’ laziness caused by the repetitive use of guided notes warranted a change in teaching strategy.

The second dilemma focused on presentation of the physical science notes. In this class, many of the students were repeating for a second or third time. According to Brittany and Diane, several of the physical science students had difficulty reading. Brittany and Diane reported that some of the students had made comments about having no ambitions of finishing the school year, much less completing high school. Brittany
and Diane had problems keeping the attention of their physical science students; the students would fall asleep, talk with other students, or write notes to their friends.

Brittany and Diane’s first physical science lesson was presented using a computer program, Power Point, with the science content in full sentences (observation, 9/5). After about 10 minutes of giving notes like this, Brittany and Diane saw how unsuccessful this was. The physical science students copied down every word. Not only did this take an extraordinary amount of time during class, but it was also very boring to the students and to Brittany and Diane. Diane described the first day of physical science notes in her interview on 9/8.

We didn’t know but when you write a full sentence on the screen, the students feel compelled to write the whole sentence. They’re not having a chance to stop and read it and ask themselves the important stuff in the definition. They’re writing down the whole thing. We need to change the whole note-giving pattern. Seeing this made me reflect more on the notes (p. 5).

Diane also explained in her interview on 9/20 that taking too many notes led to discipline problems.

Boredom often leads to bad conduct. I am trying to figure out the best way to make class interesting while they learn, but not take up too much time doing so. This is a tough one. I am also working to keep the physical science students involved so that they don’t have time to misbehave (p. 5).

Brittany and Diane never directly discussed framing their dilemma of the biology and physical science notes. However, analysis of the data from their co-planning sessions and interviews revealed a different frame than simply the presentation of the lesson; the issue was framed in terms of student learning. In their interviews, Brittany and Diane both stated that they wanted an inquiry-based science classroom.

Brittany stated in her interview on 9/20, “I think science is all about activities. I would love to do more activities on both classes” (p. 4). Diane pointed out that her
preservice education program emphasized an inquiry-based classroom. ‘In the college of education, we are taught to prompt students to inquire about science and have them figure things out for themselves’ (interview, 9/20, p. 5). She added that this type of classroom would cut down on discipline problems because the students would be more engaged in learning. ‘I think the students wouldn’t be misbehaving because they would be actively involved in their learning instead of passively taking notes’ (interview, 9/20, p. 5).

In their co-planning session on 9/10, Brittany and Diane discussed their views of student learning. To them, their students did not learn as well if all they were given were notes to memorize. The student teachers talked about how students needed activities to manipulate (p. 4), visual aids to see and solve (p. 12), and information to discover on their own (p. 6). Brittany and Diane wanted the students to be more actively involved in their own learning. Therefore, from the frame of student learning, Brittany and Diane tried several alternatives to presenting the lesson.

Reflection on the biology notes dilemma caused Brittany and Diane to begin changing the way they presented biology lessons. The student teachers tried several different activities as an alternative to the guided notes. Brittany and Diane designed an activity for the students to research the different cell organelles. The students were grouped and were given a chart and had to fill in structure, purpose, location, etc. of the various organelles. Each group researched a different organelle and presented their information for the entire class to learn (observation, 8/30). In another example while teaching mitosis, Brittany and Diane gave their students diagrams of the different stages of the cell cycle. They left space out to the side of the diagrams for the students to fill in their own explanations of each stage (observation, 9/21).
Brittany and Diane continued to make adjustments to their lesson. When teaching cell transport, the students were given a concept map. The concept map had blanks for the students to fill in. Instead of giving the notes, Brittany and Diane had the students to look up the information from their textbooks first. Then, the student teachers discussed the information with the students (observation, 9/7).

Brittany and Diane also adjusted the way they were giving notes to their physical science students. They began using guided notes in the physical science classroom. As the student teachers taught the lesson, the students followed with the guided notes and filled in the appropriate words. However, Brittany and Diane quickly noticed that the guided notes were not working either. They were losing the attention of the physical science students once again (Brittany, interview, 9/20).

On September 29, Diane individually taught physical science. She asked the students if they wanted to look up the information before they went over it. Shockingly, the class responded with a united ‘yes!’ They worked very hard for approximately 30 minutes helping each other as needed. Diane commented on this in her interview on 10/5.

When the physical science students decided to do the notes themselves, I thought that was good. I liked that. I didn’t know how that was going to work. I just blew my socks off. They actually wanted to do something on their own before I gave them the information. They haven’t taken any initiative on much else. They’re not real self-motivated students. They were just racing through filling in the notes sheets themselves. Even when we went over them, they were waiting to give their answers. I liked doing that (p. 4).

Brittany and Diane tried different activities to involve the students in their own learning. For example, the student teachers created an element activity in which the students produced an element brochure (observation, 9/26). The physical science
students had to look up important information on their element and include it in their brochure. The students drew the electron configuration of their element, wrote interesting facts about the chemical reactions of their element, and presented the information to the class.

By the end of their student teaching, Brittany and Diane went back to giving guided notes to both the biology and physical science students. Their students had told Brittany and Diane that they liked the guided notes and that they learned when they could listen to the explanation instead of frantically copying. Therefore, Brittany and Diane reverted back to the guided notes. However, they left more blanks in the notes than they had in their original guided notes because they thought this would cause the students to pay more attention.

Diane and I have done a lot of reflecting on the right way to handle the notes. We’re trying to find the right balance. We’re trying to find the best way to give notes. One of our teachers did fill-in-the-blank notes and we tried it. It worked in the beginning but then a couple of chapters down the road it didn’t seem to be very effective anymore. Now we’re trying different things (Brittany, interview, 10/12, p. 3).

Both of the student teachers felt that they were bound by their cooperating teachers and could not freely explore an inquiry-based classroom like they wanted.

I feel like the [cooperating] teachers are always breathing down our backs reminding us that we’re behind and that the students have to pass the graduation test. I think that our cooperating biology teacher is too concerned with time and quantity over interesting/hands-on and quality. So, as long at it’s “technically” not my classroom, I feel like we’re suckered into giving notes to cover the necessary material (Brittany, interview, 9/20, p. 4).

Diane added in her interview on 9/20, “we are forced to cover too much information in too little time. We barely have enough time to squeeze in an activity here and there” (p. 5). The limitations presented to them by their cooperating teachers forced Brittany and
Diane’s reflection on student learning to stop here. The student teachers were never allowed to completely work through their reflections and thus never reframed the dilemma of the biology and physical science notes.

**Student feedback.** Another trigger for Brittany and Diane’s reflection was student feedback. Many times during their student teaching, Brittany and Diane asked their students to think about the way they learned the best. Their biology and physical science students would write written comments about their science learning.

Students’ written comments were done as bellwork assignments. Brittany and Diane prompted their students’ feedback by asking questions such as:

- Biology and physical science - How do you learn best (hearing, seeing, labs, etc.)?
- Biology and physical science - What activity have you enjoyed that you would like to do more of?
- Physical science - What is the easiest way that you can show me you have learned something (tests, telling, etc.)?

Brittany and Diane used these comments to assess and change their science teaching. After trying several note-giving techniques, both their physical science and biology students stated that they liked the guided notes best. Therefore, Brittany and Diane went back to giving guided notes using more blanks. Brittany and Diane also used the student feedback to move students around in the classroom. One student wrote that he couldn’t see the overhead when one of the lights was off. Brittany and Diane moved him closer to the board for him to see well. Another student said that he was having trouble staying awake so they moved him closer also.

Brittany and Diane used their students’ responses during class to reflect on their teaching as well. They could tell by the students’ frustration when to give additional review or more explanation to a concept. The biology students told Brittany and Diane
that they felt too rushed for lab. So, Brittany and Diane made adjustments in their lesson
plans to give additional time for better understanding of the lab activities (co-planning
session, 9/10). Brittany and Diane also reflected on their students’ working as to the
amount of time to give for certain activities. If the students were working intently, more
time was given.

Brittany and Diane expected their students’ feedback to be more beneficial than
they were. The students answered the questions above by telling them that they learned
best by doing hands-on activities. They enjoyed the lab activities and wanted to do more
of them. The student teachers already knew this but were limited to the amount of time
they could spend on labs. The physical science students also said that they showed they
had learned a concept by taking a test. However, they were doing poorly on the tests, and
Brittany and Diane never resolved how to increase the test scores.

The student feedback were intended to be advantageous for Brittany and Diane to
learn how their students perceived learning and how they learned best. However, “most
of the students do not reflect too deeply in their thoughts and you may not get more than
three words out of the students” (Brittany, interview, 9/20, p. 3).

Evidence of Growth through Reflection

Reflection facilitated Brittany and Diane’s learning about their science teaching.
The data revealed that the student teachers experienced growth in several areas of their
teaching. By collaborating and reflecting with their partner, Brittany and Diane became
stronger, more knowledgeable science teachers. Growth in their science teaching was
evident in three areas: management, science content, and pedagogical content knowledge.
The dialogues, interview excerpts, and vignettes in the following sections are presented as evidence of growth through reflection.

**Growth in management.** Brittany and Diane spent many hours reflecting on how best to manage their science classroom. Diane recounted in her interview on 9/8 that ‘reflection enabled us to pick up on management skills. It brings our heads down so that we’re focused, and we’re able to perceive how to do teaching things’ (p. 3). Brittany and Diane needed to deal with management situations in their science classroom, and reflection helped them do this. Brittany and Diane wanted their students to learn science, but they also wanted their students to be motivated and engaged in the science lesson. A few times, Brittany and Diane had to deal with discipline problems, and they reflected on possible ways to handle disciplining their students.

Brittany and Diane’s reflection on classroom management included how to handle their students’ discipline. The student teachers were perturbed as to how to deal with insubordination. In their co-planning session on 9/4, Brittany and Diane discussed their physical science classroom.

D: If they’re all hyped up, we don’t need to be giving up. What do you do, we have three kids sleeping, three up out of their seats, and the others don’t care?

B: I don’t know. That’s probably a typical classroom.

D: I asked if that was normal, and he [Mr. Fulton] said it wasn’t. I’ve observed a lot of classes and I think they are pushing him to the limit as far as what they can get away with. I don’t think we should let them do all that. It’s going to be hard to go back and say they can’t do it with us.

B: I don’t want to do something like that.

D: I don’t want to either, but they’re going to do that to us.

B: I think we should walk out and flip the lights and tell them when the lights flip off, you better be . . .
D: That’s like 2nd grade lunch.

B: I know, but those kids act like 2nd graders.

D: They do.

B: They don’t notice his hand in the air. That’s not working.

D: It’s absolutely not working.

B: They’re going to notice the lights out.

D: He doesn’t have any type of punishment. Not punishment, but he doesn’t do anything when they don’t follow directions. This is the 3rd week of school. If you can’t figure out what’s going on, that’s bad. I’ll bet they don’t act like this in other classes.

B: I just don’t know at all.

D: I don’t know if it is a bad combination.

B: I think that’s part of it.

Brittany and Diane discussed the best way to get their students’ attention. They saw from the very beginning how lack of control over their students led to chaos in the classroom. Brittany and Diane didn’t like how Mr. Fulton handled the physical science students, and they didn’t think the students were learning all they could in such an environment. In an observation on 9/7, Brittany and Diane were conducting their first physical science lab. The following vignette drawn from the field notes from that observation illustrates how difficult insubordination was in their physical science classroom.

Brittany and Diane were performing their first lab with their physical science students. The students had been learning the different methods of separating mixtures. The lab directions had them filter their mixture, dissolve it in water, and boil it. After the lab was completed, the students were cleaning their stations. At this point in the lab, the physical science students were acting like class was over. They were throwing paper towels, walking around the room talking with
their friends, and being very loud. Brittany and Diane looked at each other as if they had lost control. Brittany tried Mr. Fulton’s method of raising her hand in the air to quiet the students. However, she blended in with the students, and none of the students paid her any attention. Brittany and Diane both tried to get the students’ attention with their voice, but that didn’t work either.

Since Brittany and Diane had been reflecting together at school and in their co-planning sessions, they had discussed different ways to handle discipline situations. Therefore, the student teachers tried what they had discussed in their co-planning session on 9/4 to get the physical science lab under control.

Brittany and Diane were both getting very frustrated with the lack of control with their physical science students in lab. After nothing they had tried worked, Diane remembered a discussion she and Brittany had had in a previous co-planning session. Diane walked over and turned the lights off and back on. This got the students’ attention very quickly, and they got quieter. Brittany and Diane were then able to quiet the students, get them all back to their own lab tables, and proceed with the clean-up directions.

Reflection on classroom management also caused Brittany and Diane to seek a more engaging classroom. The student teachers reflected about motivating their students to be good learners; they also spent time reflecting on how to engage their students in the science lesson. For example, Brittany and Diane reflected on the best way to conduct test reviews. The following vignette from field notes on 9/12 illustrates an unsuccessful physical science test review.

Brittany and Diane prepared a test review for their physical science students to help them get ready for their upcoming test. There were review questions that Brittany and Diane had printed and individually cut out. The review allowed the students to earn extra credit on their test if they answered the question correctly. Each student worked independently and was not allowed to use the textbook. Brittany went around to each student and had him draw a question. The student read the question aloud and answered it if he knew the correct answer. Diane kept up with the number of questions each student answered correctly. After the review, Brittany and Diane reflected on how the test review was not successful for several reasons. When one student was reading the question and attempting to answer it, the other 27 students were mostly off task. The students were talking with their neighbor, writing notes, or sleeping. The physical science students
paid attention at the beginning, but after an hour of this, they were very preoccupied. Also, some of the students couldn’t read, and this kind of review game put them in a difficult and embarrassing circumstance.

After the test review, Brittany and Diane reflected with Mr. Fulton. Diane stated to Mr. Fulton and Brittany, ‘maybe this type of review game was a bad idea. It took a long time to go around and let each student read the question out loud and answer it’” (observation, 9/12, p. 6). Brittany added, “also, a couple of students had problems reading the questions. Even though we recognized this right away and helped these students, they shouldn’t have been required to attempt to read the question out loud. That probably embarrassed them in front of their peers” (observation, 9/12, p. 6). Reflection allowed Brittany and Diane to see how they could engage all of their students in the science lesson without wasting so much time. The following vignette drawn from field notes on 9/26 reveals a more successful test review that the student teachers conducted for the subsequent test.

For the next test review, Brittany and Diane placed their students in groups of three or four and allowed them to work together to answer questions for the test review. The student teachers were in front of the entire class and read a question out loud to one of the groups. More students were involved at any particular time, and no one student was singled out to read out loud. All of the students in the classroom could hear the question and be thinking about the answer. During this test review, there were fewer students off-task and more engaged in the test review.

The data revealed that Brittany and Diane faced many management issues that had to be dealt with in order to have an effective science classroom. Management difficulties caused Brittany and Diane to reflect on their science teaching, and together they discussed possible solutions to some of their management problems. Brittany and Diane experienced growth in the area of management resulting from their reflection. They saw disobedience from their physical science students and had many discussions
about how to deal with them. Reflection allowed Brittany and Diane to discuss strategies that could be used to get their students attention. Some of the strategies were successful and allowed Brittany and Diane to maintain an organized science class. They also recognized an unsuccessful test review and reflected on how best to adjust their review exercises. The data revealed that subsequent test reviews were more effective in dealing with problems that the student teachers initially faced.

**Growth in science content.** Brittany and Diane reflected on the science content as they planned for their science lesson. Brittany had a bachelor’s degree in biology so both student teachers felt she was stronger in the science content area (Diane, interview, 9/8; Brittany, interview, 9/8). However, both student teachers helped each other learn the science content and make planning decisions about the content.

Brittany and Diane taught each other science content knowledge. Brittany and Diane helped each other learn the science content as they reflected about their science lesson. The following excerpt from co-planning session on 8/27 shows how reflection of the science content helped the student teachers learn science.

Brittany: The main organelles I thought we could cover when comparing plant and animal cells are the cell wall . . .

Diane: Do they both have mitochondria?

Brittany: Yes.

Diane: I thought so. We can do chloroplasts.

Brittany: Yes, cell wall and chloroplast, the vacuole also. It’s huge in the plant cell and small in the animal cell. The mitochondria are about the same size.

Diane: Yeah. OK, cell wall, chloroplast in plant cell. And then what else? We can do the rest of the organelles later.

Brittany: Right. So we can just skim the surface of that and go on.
Diane: About the microscope, Leewenhook invented the microscope?

Brittany: He did not invent the microscope.

Diane: On that quiz, that’s what she’s got on one of the notes. I didn’t think he did either.

Brittany: [She reads out of the book about when they were invented.]

Diane: It never comes out and says he invented it. Look at her quiz – what did Leewenhook invent? The microscope. I copied a key to this too. It never comes out and says it but it does say he used one of the first ones. I read this in another class that machine that finds longitude for sailors. It said in a book that the guy didn’t actually invent it, he was one of the first to use it but he didn’t actually invent it. Do you see it in that book anywhere?

Brittany: Let me look in my college book. This one doesn’t really say anything about it. Let me look in this other one. I was confused the other day when someone asked if all cells had a true nucleus. She said that almost all of them do. I think it is important to remind them that science almost always has exceptions.

Diane: Protists don’t have a true nucleus, do they? No, not protists. What am I thinking – it starts with a “p”? Prokaryotic. Do they have a nucleus?

Brittany: No, isn’t that what it means, “no nucleus.”

Diane: They lack no membrane-bound compartments. Does that mean no nucleus?

Brittany: Yes.

Diane: See, they make such general statements. I hate to just assume that’s what it means. Eukaryote means true . . .

Brittany: True nucleus. This book says that Hooke used a compound light microscope to study pores. It doesn’t say he invented it.

Diane: Does it say anything about Leewenhook in there?

Brittany: No, it doesn’t say anything about him. It goes on to talk about these other scientists. Oh wait, it just mentions he invented the cell theory.

Diane: Nothing about him and the microscope.

Brittany: No.
From this conversation, Brittany and Diane co-constructed the biology content. Brittany helped Diane answer questions about mitochondria, the microscope, and the definition of prokaryote. The student teachers also helped each other learn the content by looking up the information in their texts. The student teachers had discrepancies about Leewenhook and whether or not he invented the microscope. They looked to Dr. Smith’s notes to answer their question, but found nothing in her notes to clarify their confusion.

Another example comes from co-planning session on 8/27. Brittany and Diane discussed surface area to volume ratio.

B: How do you want to explain surface area to volume ratio? Just that you’re more efficient when you have more surface area?

[Diane reads texts from the book]

D: Because if it was huge and you had a waste product in the very middle, you had to travel 10 miles as opposed to something that was small traveling one mile to get the waste out of the cell.

B: What about different kinds of leaves?

D: Yes.

B: Cactus leaves are real thick

D: Yes that’s the train of thought that I’m going with. You have cactus leaves that are short and fat. Well, the spines are more modified leaves but it’s still surface area. You have certain leaves with big surface area . . .

B: . . . that are real thick and leathery to hold in water. When you’re thin like the leaves on a tree, you’re going to lose more water. A lot of the leaves are already turning yellow because we haven’t had any rain. They’re so thin, they have a high surface area and don’t hold in water that well. We can do it that way. I can even break leaves off my plant. That’s the most practical example I can think of.

D: OK, you could use the example of the thick plants being the ones that lived in the desert in the dryer climate and they can’t afford having things flying out of the cell as opposed to the thin ones who need lots of water so they need more surface area to take in more.
B: You can see when you cut open the aloe plant, juice comes out.

D: Yeah, I got the idea. That’s going to be the example of distribution within the cell?

B: That’s the surface area to volume ratio. The distribution, we’re going to do the paper clip. There’s a picture of the surface area to volume ratio.

D: The caption says that smaller cells are more efficient than larger cells.

B: You want to have a high surface area to volume ration instead of low. Is that right?

D: Say that again?

B: That confuses me. Six to one is a high ratio?

D: Yes.

B: And that’s more efficient?

D: Yes. A higher ratio means it is more efficient. Because that way the center of that one big cell.

Reflection on the science content caused Brittany and Diane to learn the content as they prepared to teach their science lessons. The student teaching pair explained the content to each other and clarified areas of confusion. Brittany and Diane helped each other learn the ratio between surface area and volume of a cell. The student teachers discussed, explained, and used examples of how smaller cells are more efficient than larger cells.

Having a student teaching pair allowed them to work through difficulties they had about science content before actual teaching. The student teaching partners taught each other the science content. By doing so, Brittany and Diane were confident in their content knowledge and in their science teaching.
Growth in pedagogical content knowledge. Shulman (1987) termed the phrase ‘pedagogical content knowledge’ to describe teachers’ knowledge about their subject matter in relation to how to teach that subject. Pedagogical content knowledge describes the knowledge teachers have when they are able to present the subject matter in a way that is clear and understandable to their students. Brittany and Diane never discussed “pedagogical content knowledge” per se. They never used the term directly to characterize their reflection on their science teaching. However, analysis of the reflection data revealed many instances where Brittany and Diane reflected and helped each other develop pedagogical content knowledge. The student teachers’ reflection of pedagogical content knowledge included designing activities, using analogies, synthesizing the science content, and sequencing the order of the lesson.

During their co-planning sessions, Brittany and Diane discussed the design and format of their lesson. For example, they used the science content to determine what lab information to present (which labs to perform, what information to put in the lab sheets, what directions to print, and which materials to use). The lab discussed below (co-planning session, 8/27) was a microscope lab where the students looked at different types of cells at different magnifications. Brittany and Diane reflected on the science content to create questions and design the lab for their students.

B: What questions do we want to leave [from Dr. Smith’s lab]?

D: They’re going to be answering the questions and drawing it on their own paper. There’s no need to leave huge blanks. Tuesday, we need to cover that in class.

B: How to label?
D: Yes. I would just put in the directions, “observe and label an onion cell under a certain power.” They could draw and label at every power. No, that’s too much.

B: Do you want to keep all of the conclusion questions?

D: Definitely #1. I think they should know #2. On #3, we have to leave some of the directions in there. Should we list what we expect them to have in their drawings?

B: Yes, cell wall, chloroplast, cytoplasm, and nucleus. The same for the leaf and onion cell.

D: I don’t think you can see the nucleus in the onion. Can you?

B: Yes, it says so here. Cell wall, cytoplasm, and nucleus for the onion. The same three plus the chloroplast for the leaf.

D: They need to observe the leaf on high power.

B: OK, and draw and label those four things. Then the cheek cell, they need to label cytoplasm, nucleus, and cell membrane.

D: Yes.

B: I’d say leave in all of the conclusion questions.

D: We’ll have to give them specific directions on how to scrape the cheek. They take a toothpick, scrape it on their cheek, and throw the toothpick away.

B: Stress cleanup on the cheek thing.

Pedagogical content knowledge (PCK) is knowledge that teachers have about how to present science content. The above dialogue gives evidence of Brittany and Diane growing in their PCK. The student teachers discussed a way to organize the science content into an interesting learning experience for their students. Brittany and Diane made the laboratory activity as clear as possible so that their students could focus on the lesson and not be confused about the instructions.
Another important aspect of pedagogical content knowledge is the use of analogies and metaphors that teachers use to present science content. During co-planning session on 8/27, Brittany and Diane discussed the efficiency of small versus large cells. They reflected on the science content and decided that an analogy would help the students understand the concept.

B: We are going to finish on Monday that cells have to be small. Let’s figure out a couple of things to say about that.

D: I think it’s important that we talk about that because it’s something you think is a given, but it’s not. What about the relationship of the exchange of materials between cells, between the inside of the cell . . .

B: We can come up with a good analogy for that.

D: Talking about the distribution of materials within the cell, I’m trying to think what we did on osmosis at another school I worked in. We discussed that’s why cells are small, so ions can diffuse quickly and easily.

B: Well, not even just that, where the vacuole travel back and forth from the Golgi to the ER and back, efficiency wise, it’s more practical to have to go only a little distance than a huge distance.

D: We could set up an activity where you have two students get up. You have a bucket of marbles at the door and have them bring them back one by one to two different places – one close and one far away. I think they would remember that cells have to be small because of the distribution reasons.

B: Yes, we could do that.

D: Or we could use a little pile of paper clips.

B: She has that big bucket of paper clips. We’ll use that. This kind of activity makes you remember it.

From their reflection on the science content, the student teachers created an activity to teach their biology students about the efficiency of smaller cells (observation, 8/29). They piled paper clips in the center of the room. One student (a small cell) carried a paper clip one at a time to a point half way to the door. Another student (a large cell)
carried a paper clip one at a time all the way to the door. The student going half way (the small cell) carried more paper clips, thus representing a more efficient cell.

In the above dialogue, Brittany and Diane took a difficult but important biology concept and created an activity that helped their students better understand the concept. Brittany and Diane reflected on the science content to decided how best to present it. The student teachers discussed the science content and gave suggestions about the analogy to use. Both student teachers contributed to each other’s growth in PCK.

A third piece of evidence that showed Brittany and Diane’s growth in pedagogical content knowledge was synthesizing of the science content. Teachers with PCK understand how to show the relationships between science concepts. Brittany and Diane helped each other better present the science content so that their students would see the big picture of the science concept and be able to better synthesize the science content.

In one lesson, Diane individually taught mitosis (observation, 9/21). Diane explained the different stages of mitosis, and the students completed several activities and labs on mitosis. However, Brittany noticed that the students were not seeing the big picture by the frustration on their faces. Through reflection, she and Diane decided that Diane should draw a diagram of the stages of mitosis and their relationship to each other.

I taught the students about the different stages of interphase, and then I moved onto the different stages of mitosis. The way that I presented it in 2nd period seemed fairly clear to me. For some reason, the students were having trouble seeing the “big picture.” In reflecting with Brittany after class, she had some suggestions on how I could help the students see the different stages in regard to the big picture. She didn’t feel that it was clear to the students. Therefore, I modified my lesson for fourth period by using Brittany’s suggestions. I explained the big picture in more detail. The students seemed to catch on quicker. This was just one of the times that I can think of that she has helped me to modify my science teaching (Diane, interview, 10/5, p. 2).
In another example, Brittany individually taught replication, transcription and translation (observation, 9/29). She had the same problem Diane had with mitosis; the students were not synthesizing the information. The students did not see how the processes were related. After reflecting with Diane, Brittany decided to use a diagram to show the processes of replication, transcription, and translation and how the processes were related to each other.

We had done transcription the day before. Some of them were getting it, and some of them were not. Yesterday, before class, I made a big picture of replication to transcription to translation. They could see the big picture laid out together. We thought that would help instead of having individual processes. You need to see where you start and where you finish. The students said it helped them see the big picture (Brittany, interview, 10/12, p. 2).

In each of the two circumstances, Brittany and Diane grew in their PCK. They worked together to help their students understand the science content in a clear and concise way. The student teachers learned more about how to teach the science content that would lead to better understanding by their students.

Finally, Brittany and Diane’s growth in pedagogical content knowledge was revealed through their reflection on the sequence of the lesson. After reflecting on some teaching mistakes, the student teachers learned better decisions about the succession of the science lesson that helped their students. Many times, Brittany and Diane adjusted the order of some science concepts for fourth period after teaching second period. For example, Brittany and Diane realized after teaching about prokaryotes that they should break down the meaning of the word (pro- meaning before and –karyote meaning nucleus) before describing their characteristics (observation, 8/28). Brittany and Diane also realized they should explain the definition of organelles before they began using the
term in the lesson (observation, 8/29). These adjustments were made for fourth period, and their students had fewer questions.

Reflection also occurred about the order of the entire lesson. For example, Brittany and Diane planned together but taught the biology classes individually. Brittany taught second period biology, and Diane taught fourth period. The following vignette drawn from field notes on 9/12 illustrates how the order of the lesson caused Brittany trouble.

Second period began as the students worked on their bellwork, reading over the lab directions for today. Brittany had planned to teach a few new concepts to her biology students and then take them to lab. However, Dr. Smith, because of a personal dilemma, needed to leave halfway through first period. She wanted to be with the students in lab, so she suggested to Brittany that she take the students directly into lab instead of doing lab at the end of the period. As the biology students worked on their bellwork, they immediately had questions. Many of the concepts they had not learned and were supposed to learn before going to lab. Brittany told them as much as they would need to know for lab. Once in the lab room, the students asked many questions about the lab sheet, and Brittany had to tell them to skip some questions because they had not gone over them yet. The entire lab was chaotic because the students were confused about the instructions and the purpose of the lab.

After class, Brittany and Diane talked about how unsuccessful the lab was. The confusion from the students caused the lab to be unsuccessful which further frustrated the teachers. The students were confused when they returned to class and Brittany had to spend much of the remaining class time answering questions about the lab and clarifying the science content. The student teachers decided that Diane should rearrange the order of the class in order to avoid such confusion. The following vignette shows how this reflective decision created a smoother, less confused class (observation, 9/12).

Diane began fourth period with a similar bellwork assignment. Then, instead of going to lab first, Diane explained the science notes before lab. Much of the content Diane explained was needed for the students to use in lab. Diane also thoroughly explained the lab activity before going to lab. She emphasized the
directions and concepts in the lab that had perturbed the second period students. Diane took the time to go through the lab directions and questions the students were to answer from their results. The fourth period students had fewer questions and better understood the intention of the lab, the directions, and the questions.

Brittany and Diane’s reflection on PCK helped them adjust their science teaching so that their lessons were more successful. They saw how their teaching could be improved and how their students could better understand the science content. Brittany and Diane grew in their PCK and learned a significant part of teacher knowledge.

Mechanisms of Reflection

Brittany and Diane’s reflection was influenced by different mechanisms, and they used a variety of tools to work through their reflection. They used their remembered stories as learners to respond to their problems encountered in teaching. However, it was their partner collaboration that was perhaps the most significant source of knowledge. Partner collaboration included suggestions, tensions, and support.

Knowledge base for reflection. Brittany and Diane used their experiences as a knowledge base for reflection. Use of their past learning experiences occurred mostly during Brittany and Diane’s co-planning sessions. While planning the science lesson, the student teachers reflected on their knowledge from being learners to assist them in planning activities, using different learning strategies, and self-understanding of the science content.

Use of Brittany and Diane’s past learning experiences prompted the use of a variety of activities. For example, Brittany mentioned that she remembered learning the phases of matter by seeing her classmates act out the phases (co-planning, 8/27). Several students ran quickly around the room as a gas; they moved slower and closer together as a liquid; and they were fixed with very little movement as a solid. Diane agreed, ‘I
remember things like that from class, getting up and doing something” (co-planning session, 8/27, p. 12). So they performed that activity with their physical science students.

A learning strategy that Brittany and Diane incorporated into their classes was assigning textbook reading before the lesson. Diane told Brittany that it made more sense to her when she was learning something new when she had seen the material before hearing it from the teacher.

I think it will be better if we give them time to read the text and think about it. Then we talk about it. I know it always helped me if I read something before the teacher talked about it. Maybe I didn’t know exactly what I was reading or understand all that was going on, but at least I had read that word and could make that connection (Diane, co-planning session, 8/27, p. 9).

The student teachers gave reading homework, assigned definitions for bellwork to expose the students to the words they would discuss that day, and had their students answer questions in their text before going over the material.

Brittany and Diane’s past learning experiences also helped them understand the science content. They remembered areas where they were confused as students and needed more help such as the reactions of photosynthesis and punnett squares in genetics (co-planning, 9/4). Brittany and Diane made sure that they had extra practice and spent a little more time during these tough subjects. They also used past learning experiences in creating pictures and diagrams for the science content. For example, when teaching their biology students about the microscope, Brittany and Diane searched their college notes for pictures of different microscopes because, as learners, they didn’t understand all of the content about the microscope until they had seen one (co-planning, 8/27).

**Suggestions.** Being paired during student teaching allowed Brittany and Diane many opportunities to reflect with their partner. Brittany and Diane both stated that
reflection was one of the greatest advantages of having a student teaching partner. ‘By having a partner, I feel as if I had an immediate source of instant feedback. I liked having someone to talk to right then and there about problems that I may have with something at school’ (Diane, interview, 12/12, p. 5).

Throughout their student teaching, Brittany and Diane watched each other teach on most occasions. While their partner was teaching, many times Brittany and Diane critiqued their partner’s performance. They saw their partner’s lesson and gave authentic suggestions and reflection on their partner’s science teaching.

Having an additional person in the classroom is really helpful because the non-teaching person has a completely different perspective on the class and sees many things that the person in the front of the classroom does not see. This enables that person to give you feedback on the class itself so that you can be more aware of changes that need to be made. My partner helps me reflect on my science teaching by pointing out things that I might need to run back through or things that went exceptionally well/poorly. She also points out bad habits that I need to watch out for when I’m speaking in front of the class (repetition of words, not explaining a concept thoroughly enough, etc.) (Brittany, interview, 9/20, p. 1).

After receiving suggestions about their teaching, most of the time Brittany and Diane modified their teaching to improve the problems their partner pointed out. The changes were made in between classes or for the next day. Reflection on their partner’s suggestions improved their science teaching.

There’s a minor lesson that didn’t go that well for Diane that I sat and wrote some things to change for 4th period. Some of the things were small that she needed to work on like repeating words and talking to the chalkboard instead of the class. I also thought it would be better to go back through the big picture of mitosis again on the chalkboard. I think she wanted to go through it again but ran out of time. We had the magnets to do on the chalkboard [to show how mitosis occurs]. I thought it would help them to go to the board and go through the chromosomes and go through and move the chromosomes through at each stage. I suggested that she try to work that into 4th period. It went better (Brittany, interview, 10/12, p. 5).
Tensions. Sometimes, the student teachers gave suggestions to their partner that were not taken, thus creating tensions in their peer collaboration. There were two instances during their student teaching where Diane made suggestions to Brittany that were not taken. Brittany did not use either of these suggestions to adjust her science teaching. Diane described this in her interview on 9/20.

Brittany prepared an activity for the biology class on genetics. The activity made sense to her because she had planned it out and read over it several times. As I sat in class (seeing this activity for the first time), I didn’t fully understand what she wanted the students to do based on her verbal instructions. I don’t know that I would have known exactly what to do had I been doing the activity. After 2\textsuperscript{nd} period, she made the comment that the students don’t listen and don’t follow directions. I mentioned to her that I didn’t think that the directions for the activity were clear enough and that she might want to elaborate more on them for 4\textsuperscript{th} period. The next class had the same problems as the first class. I am not sure why she chose not to go into more detail with the directions. On the other hand, she may have felt that she DID elaborate more on the instructions (p. 1).

Another suggestion Diane gave Brittany was to give more examples of punnett squares.

I critiqued Brittany on the punnett squares. I don’t think they did enough examples. Today is the test, and this morning, we had several students in for the review. They were asking, “what’s this block thing?” The test is today. With punnett squares, you can teach until you're blue in the face. Until the students have to do it themselves, they don't get it. Brittany didn’t give enough examples. I would have given them more homework on that. I think back to when I was there. You’re not going to learn it unless you go home and practice – especially punnett squares (interview, 10/5, p. 4).

While Brittany and Diane’s collaborative student teaching was filled with many successful interactions, there were some uneasy moments. In both of the above stories from Diane, she thought that her suggestions to Brittany would have improved Brittany’s teaching. Brittany listened to Diane’s suggestions and did not argue about why she should keep her teaching the same. The student teachers never discussed the situations again.
Support. By having each other in the same classroom, Brittany and Diane reflected on their partner’s mistakes that they could’ve easily made. They offered support to each other about their science teaching. Diane told in her interview on 9/8 that one student teacher couldn’t make all of the mistakes. Having a partner allowed Brittany and Diane to learn from two sets of mistakes instead of one. Brittany told how they consulted each other when they made a mistake (interview, 9/20). Diane added that many times, it was easier for her to go to Brittany than to ask Dr. Smith.

With us working in pairs, you’re seeing your peer going through the same thing that you’re going through. I think it’s good that you have that immediate critique of what you just did. Even though you can talk with your mentor teacher about it, it’s good that you have your peer to talk with about teaching. It’s easier to take criticism from your peer than from your mentor teacher. I think they’ll be more honest too about your teaching than your mentor teacher might. I think it’s been very beneficial (Diane, interview, 9/8, p. 1).

Reflection not only occurred from their partner’s critiques, Brittany and Diane also reflected on themselves from watching their partner teaching. “While my partner is teaching, I think about how I would change the lesson”(Brittany, interview, 9/20, p. 6). Brittany and Diane pointed out many times that they watch and learn from their partner’s science teaching. They saw teaching techniques they wanted to add to their own teaching as well as items they would not include in their own lesson.

When Brittany is teaching, I learn lots of classroom management techniques that I either like or don’t like. This shows me that I am probably doing twice as many things in my lessons that I don’t see that I see by watching Brittany. I am able to see some of the things that go on in her teaching and in turn ask myself if I am doing those same things. By watching Brittany’s teaching, I see many things that I like and things that I don’t like. I try to incorporate the things that I like into my own lessons and make a conscious effort not to do the things that I don’t like (Diane, interview, 9/20, p. 7).

Brittany and Diane also used what their partner learned from other teachers to help improve their science teaching. Brittany stated in her interview on 9/20 how she
used a note-giving method that Diane learned after observing another science teacher at Southeast High School.

After observing another physical science teacher last week, Diane saw that she used a different method for giving notes, so now we’re both trying that method for the first time instead of the fill-in-the-blank notes. Those have gotten to be just too boring. We are able to feed off of one another’s ideas to watch out for things that are and are not working (p. 2).

When asked what the student teachers reflect on together, Diane answered, ‘everything, definitely management. It seems like every time the students leave, we talk about how to handle students. We discuss what students say to us and how we should have handled it. We talked about what we would have done to specific situations. A lot of times, we talk about the science content. Anything that happens, we talk about it. It continues when we’re in the car. We talk about who puts forth or doesn’t put forth effort” (interview, 10/5, p. 3). Diane summarized having a partner by stating, ‘I learned how to become more critical of myself because she was constantly giving me constructive criticism” (Diane, interview, 12/12, p. 7).
CHAPTER 5

DISCUSSION

Summary of the Findings

This research study was designed to look at a collaborative student teaching placement in a high school science classroom. More specifically, this study investigated the types of collaborative interactions that took place between the two student teachers and the role of reflection during the collaborative student teaching. Two research questions directed the study:

1. What types of collaborative interactions do the paired student teachers engage in, and how do these interactions facilitate learning to teach science?
2. What does reflection look like in paired student teaching? What evidence is there of reflection in paired student teaching?

Below is a summary of the major findings for each of the research questions.

Collaborative Interactions

Brittany and Diane collaboratively interacted with each other throughout their entire student teaching experience. Even when they planned and taught individually, they ran science-teaching ideas past each other and assisted their partner when needed. While there were many collaborative interactions that occurred between the student teaching pair, the data revealed two main interactions: division of teaching responsibilities and giving two explanations.
Division of teaching responsibilities. Beginning from the first day of their student teaching, much of Brittany and Diane’s focus was on “who would do what.” Every discussion in their co-planning session, each conversation at school, each one of their lectures included dialogue about the division of their teaching responsibilities. When planning their teaching, Brittany and Diane volunteered to teach specific concepts, run off copies of a lab, or discipline a student.

Within the context of dividing the science teaching responsibilities, the data revealed that Brittany and Diane divided administrative issues, science content preparation, and science teaching. Administrative issues included grading papers, taking attendance, and disciplining students. Dividing science content preparation involved such tasks as preparing worksheets and searching for information for their teaching. Brittany and Diane also divided actual science teaching that included giving notes to the students and answering students’ questions.

The data also revealed that Brittany and Diane divided their different science teaching responsibilities on different occasions. The science teaching responsibilities were mostly divided during class while administrative issues and content preparation were divided during planning time. Finally, the research data uncovered that Brittany and Diane’s teaching responsibilities were divided by the student teachers working separately on the same science teaching concept or working separately on different science teaching concepts.

Giving two explanations. The other significant collaborative interaction that Brittany and Diane engaged in was giving two different explanations in their science classroom. Upon analysis of the data, four types of interactions emerged in which
Brittany and Diane presented two explanations: explaining content, giving directions, answering questions, and disciplining students. Brittany and Diane built upon each other’s examples during their science teaching to give their students a richer picture of the science content. Two explanations were also helpful when giving directions for a science lab, class activity, or homework assignment.

Answering their students’ questions was perhaps the most useful area of giving two explanations. Sometimes one of the student teachers did not understand a student’s question. Her partner interjected and helped answer the question. Having two explanations gave the students a more complete answer. Finally, Brittany and Diane presented two explanations when disciplining their students. It was helpful to have another viewpoint when dealing with such an important but sensitive area of science teaching.

Reflection

Reflection was an important tool that Brittany and Diane used to help them become better science teachers. The student teachers reflected individually and collaboratively as they learned how to teach science. By using reflection, Brittany and Diane developed science teaching concepts that were useful in their learning to teach science. It was especially meaningful that the student teachers had a partner with whom to reflect. By reflecting as a student teaching pair, Brittany and Diane were able to deal with many issues that arose during their student teaching experience and grow as science teachers.

Triggers for Reflection. Sometimes, reflection occurred as a natural part of Brittany and Diane’s conversations about their science teaching. However, many times,
something triggered the student teachers’ reflection. Triggers caused Brittany and Diane to reflect on their science teaching to seek improvements that could be made. The triggers that caused Brittany and Diane to reflect fell into two areas.

First, the student teachers encountered dilemmas. The presentation of the biology and physical science notes was the biggest dilemma the student teachers experienced. This dilemma was framed in terms of student learning. Brittany and Diane tried several ways of presenting their notes trying to make their instruction more engaging and interesting for their students. However, limitations placed on them by their cooperating teachers constrained their freedom to thoroughly reflect and work on this dilemma. The second trigger that brought about reflection was feedback from their students. Brittany and Diane used their students written feedback and responses during class to reflect on and adjust their science teaching.

**Evidence of Growth through Reflection.** In their collaborative student teaching, reflection helped Brittany and Diane experience growth in several important teaching areas. The student teachers reflected on their own science teaching and on the science teaching of their partner. By using reflection, Brittany and Diane experienced growth in their understanding of management of the science learning environment, science content understanding, and pedagogical content knowledge.

Reflection on the management of their science classroom occupied much of Brittany and Diane’s time. Management reflection focused on disciplining their science students and increasing engagement in their science classroom. Brittany and Diane used management reflection to determine the best way to discipline their students. The student teachers wanted their students to be encouraged to learn science. Brittany and Diane also
wanted their students to be engaged in the science lesson. The student teachers reflected and adjusted the way they handled test reviews to make the students more involved in the science classroom.

Secondly, reflection helped Brittany and Diane grow in the area of science content knowledge. By reflecting with each other, the student teachers were able to help each other better understand and learn the science content. They answered each other’s questions and talked through the science content they would be teaching. Reflection in a collaborative setting allowed Brittany and Diane to also work through misconceptions they had about the science content.

Finally, reflection assisted the student teachers in their pedagogical content knowledge. The student teachers used reflection to design effective science activities that assisted them in their science teaching. By reflecting as a pair, Brittany and Diane learned how to show their students the “big picture” of science concepts and synthesize the science concepts that were presented to their students. Collaborative reflection also revealed a better way to sequence their science lesson. Brittany and Diane adjusted the order of their lesson after reflecting on a better arrangement of the science concepts.

Mechanisms of reflection. Brittany and Diane used several mechanisms and tools to enhance their reflection. The knowledge they had experienced as learners benefited the student teachers by giving them knowledge to draw upon. Brittany and Diane also used their collaboration with each other to assist their reflection. The suggestions, tensions, and support they experienced during collaboration strengthened their science teaching and their reflection.
The data on Brittany and Diane’s collaborative reflection revealed that they used their knowledge from their experience as learners to enhance their reflection. Reflection on their past learning experiences helped Brittany and Diane with their activities and learning strategies they would use to teach the lesson and with their self-understanding of the science content.

Brittany and Diane observed each other and offered useful suggestions that were used to modify their science teaching. The student teachers also extended their support for their partner. Brittany and Diane supported each other when mistakes were made and when questions arose about their science teaching. A couple of times through their suggestions and support, tensions appeared. These were times that their partner’s advice was not taken.

Conclusions and Implications

While this research study found some of the same conclusions as similar research investigations (Lemlech, Hertzog, & Pensavalle, 2000), this study adds to the literature on collaborative student teaching and reflection in a significant way. The data revealed valuable collaborative interactions in which the student teachers engaged. The study shows teacher educators one example of what collaboration looks like in a paired student teaching placement. This study also uncovers ways that collaborative reflection helped Brittany and Diane learn important teaching strategies and grow as science teachers. Several significant implications for teacher education emerged from this collaborative research study.
Implications from Research Data

First, paired student teaching allowed the student teachers to focus on the science content and science teaching techniques because they divided the workload and experienced more science teaching roles. Brittany and Diane assumed a variety of teaching roles during their student teaching including observer, team teacher, full-time teacher, one-on-one teacher, lab instructor, tutor, an assistant to her partner, and a teacher to her peer. Brittany and Diane also divided the roles of planner, researcher, learner, supporter, and critic.

Dividing the science teaching responsibilities allowed Brittany and Diane to reduce some of the ordinary teaching chores such as grading papers and creating class activities. Dividing the teaching responsibilities also allowed them to focus more on the science content, lesson plans, and presentation of material instead of copying papers, handing out absent assignments, and disciplining students. Brittany and Diane were able to pay more attention to the teaching process instead of “busy work.”

Second, paired student teaching provided two explanations of the science lesson. Collaborating during student teaching gave the student teachers a chance to build off of each other’s ideas. By having more than one explanation about the science content, the student teachers were able to give their students a more extensive description of the science lesson. Also, having two student teachers with two explanations filled in gaps in the science learning environment. This result corresponds with the suggestion by Vail, Tschantz, and Bevill (1997) who propose that having different explanations can bring the best solution to the most difficult problems.
Bullough, et al. (in press) found similar results in their study on paired student teaching. They found that the students of the paired student teachers learned more content and learned it more quickly due to multiple explanations being given from two teachers. Brittany and Diane had different backgrounds that caused them to bring in different outlooks on science teaching. Therefore, the student teachers used different analogies and descriptions when explaining the science content. Providing different viewpoints became a mechanism for reflection.

Third, by pairing student teachers, teacher educators provide more opportunities for reflection. Collaborative reflection was important to Brittany and Diane’s learning in that they had a “critical friend” (Hatton and Smith, 1995, p. 37) to learn with them. By having the same students, teaching the same science content, and experiencing the same teaching dilemmas, Brittany and Diane reflected in many aspects of their science teaching.

Fourth, paired student teaching promoted growth in science teaching primarily in the areas of management, science content, and pedagogical content knowledge. Motivating their students to learn science did not come easy. Brittany and Diane struggled throughout their student teaching with ways to better present science notes. The student teachers reflected daily on strategies for giving notes and tried several methods of making their notes better for their students. Reflection helped Brittany and Diane work through this dilemma. However, at the end of their student teaching, neither student teacher was completely satisfied with how they were giving notes. Brittany and Diane weren’t satisfied with any of the note-giving methods. They weren’t fully allowed to experiment and reflect on all possible forms of presenting the science content.
Helping their partner learn the science content was an important aspect of reflection for Brittany and Diane. The student teachers debated some of the content and together arrived at an acceptable explanation. Studies show that questioning and deliberating on dilemmas expands understanding (Brown & Palinscar, 1989; Webb, Troper, & Fall, 1995). Studies also show that working with peers allows them to discuss what they are learning and work through misconceptions (Driver, 1995; Duit, 1995; Webb, Troper, and Fall, 1995). Group settings allow discussion of the content and helps and make it explicit. Brittany and Diane made their understanding of the science content explicit and available for reflection.

This study adds to the literature by discussing how preservice teacher collaboration helped student teachers develop pedagogical content knowledge. Brittany and Diane learned how to improve their teaching practice by using collaborative reflection. Pairing student teachers reduced the amount of workload and allowed the student teachers time to “fine-tune” their lessons, thus developing their pedagogical content knowledge. Brittany and Diane’s teaching schedule was conducive to Borko and Livingston’s (1989) suggestions of reducing the teaching load. By teaching together and then teaching only one subject individually at a time, Brittany and Diane were able to devote more time to making their science lessons suitable for their students.

As Lemlech and Hertzog’s (1999) study found, many student teachers are limited in their pedagogical content knowledge. Student teachers highly depend on their cooperating teacher for help with how to relate subject matter to their students. Brittany and Diane asked their cooperating teachers questions about the teaching science to their students. However, they depended on their partner for pedagogical content knowledge as
well. Pairing Brittany and Diane helped these novice teachers to develop understanding and skills well beyond the novices described by other researchers (Borko & Livingston, 1989; Lemlech & Hertzog, 1999; Livingston & Borko, 1990).

Finally, collaborative student teaching provided an environment of support and encouragement. Brown and Palinscar (1989) showed that collaboration with others provides opportunities for sharing problems. Having a partner provided reflective cohorts that were available to help resolve dilemmas that arose. The role of support in a social learning environment is one of the greatest roles in group learning environments. According to Brown and Palinscar (1989), group members spend more time motivating, encouraging, and being a friend than actually solving problems. Brittany and Diane were supporters of each other. Being paired in student teaching gave the student teachers an automatic advocate who was there to inspire and encourage their peer teacher.

Tensions in group learning environments is also a catalyst for change (Brown & Palinscar, 1989). Group members who are confronted about a conflict are compelled to justify their reasoning and possibly seek an alternative perspective. While there were a few tensions during Brittany and Diane’s student teaching, none of them were ever discussed in detail or solved. Diane made several suggestions for Brittany’s teaching that she thought would improve their students’ understanding. However, Brittany didn’t adjust her teaching or seek to explain to Diane her reasoning for not changing her teaching. More research will be needed to disclose the role of tensions in collaborative student teaching.
Implications for Designing Collaborative Placements

The collaborative student teaching placement described in this research study was a trial placement by Southern State University. Three implications about designing collaborative student teaching placements are proposed as a result of this research study. First, the paired student teaching experience described in this research study was the first at the Science Education Department at Southern State University. The requirements and guidelines given to the student teachers did not include guidance on their collaborative student teaching experience. This was advantageous in that it allowed the researcher to see the kinds of collaborative interactions that unfolded. Having no guidelines on collaborative student teaching also allowed for the natural interactions between the student teachers, cooperating teacher, and university supervisor to emerge.

However, guidelines concerning collaborative student teaching (i.e., individual/paired teaching time, division of teaching responsibilities, and partner accountabilities) would help a paired student teaching placement run more smoothly. Below are some specific guidelines based on the results of this study.

1. Teacher education needs to provide preservice teachers with many opportunities to collaborate with their peers. As this study has shown, collaboration with peers is a beneficial learning tool. The results of this study suggest that collaboration is beneficial because it can provide growth in management, science content, and pedagogical content knowledge. Collaboration helps novice teachers distribute administrative tasks. Therefore, planned experiences in collaboration can begin earlier in teacher preparation.
2. Student teachers should be given guidance on how to critique their partner and provide feedback. Brittany and Diane critiqued each other and helped their partner reflect on their teaching. However, they reported only noticing superficial items such as talking to the chalkboard or not walking around the room as often as necessary.

I wish we knew things to look for in the other one’s teaching. We were never given a thing for some ways to reflect – ways that I wouldn't have known to look for. You mentioned some things about the flow of the lesson, not just saying “Um” too many times – to look for the deeper reflection things. If I knew what to look for, I could keep my reflection changing. Right now, I just sit there and listen to Brittany’s lesson (Diane, interview #3, p. 1).

This points to the importance of the cooperating teacher being educated in collaboration. Teacher education needs to provide opportunities prior to student teaching (i.e., methods courses, practicum experiences) where preservice teachers have a chance to critique one another’s teaching. The critique should be lead by a professor who could guide student teachers in critiquing their peers and in facilitating reflection based on the critiques. This would benefit all student teachers not only those who are paired during their student teaching.

3. Paired student teachers need assistance when working through tensions that occur. The results from this study showed two instances where tensions between Brittany and Diane arose. Brittany did not know what to do with the suggestions Diane made. More communication tools should be provided to help with resolutions. The student teachers were not able to work through these tensions to resolve the discrepancy. If the student teachers had prior experience or supervision in working through the tensions, both Brittany and Diane would have benefited as well as their biology students.
As a second implication for designing a paired student teaching placement, caution needs to be used when assigning student teaching pairs. Extreme care was used in Brittany and Diane’s student teaching placement seeking to obtain a personality fit for both student teachers. However, both Brittany and Diane point out that pairing during student teaching could be unsuccessful with clashing personalities.

Lemlech, Hertzog, and Pensavalle (2000) reported that personality matching was a lesson they learned in the 12 years of developing their collaborative student teaching program. They summarized some of the main relationship problems as being:

- inappropriate choice of partners
- communication problems between partners
- development at different rates
- jealousy and personality needs
- conflict with supervising teacher by one of the partners
- over-dependence by one partner on the other
- sharing responsibility (p. 13).

While teacher educators cannot ensure that 100% of their student teaching placements are flawless, knowledge of some of the possible potential problems can most likely prevent most mismatches.

Third, if teacher education programs intend to implement a collaborative student teaching placement, university supervisors, cooperating teachers, and preservice teachers need to learn about the power of collaboration. University professors need to be knowledgeable about collaboration and begin implementing collaborative interactions prior to student teaching. The Science Education Department at Southern State University pairs some preservice teachers during their practicum but others work individually. Collaborative opportunities at all levels of their teacher education could be given to preservice teachers.
Education on collaboration would also be helpful for cooperating teachers. Dr. Smith, Brittany and Diane’s cooperating teacher, had participated in a cooperating teacher program (Teacher Support Specialist), but it did not include how to work with paired student teachers. Lemlech, Hertzog, and Pensavalle (2000) report that many cooperating teachers were against supervising a pair of student teachers until they had been instructed on collaborative student teaching. Collaborative student teaching could be a significant part of all cooperating teacher education.

**Suggestions for Further Research**

Pairing student teachers is a creative, innovative, and successful way of adjusting the traditional student teaching model. Many universities are incorporating some type of collaborative student teaching into their teacher education program. While Brittany and Diane both enjoyed and learned from their paired student teaching placement, teacher education programs need to consider several recommendations for future implementation of collaborative student teaching placement. The conclusions to this research study leave teacher education with several suggestions for further research.

First, an interesting suggestion for further research would be to follow the paired student teachers into their first year of teaching. A more in depth study to see how paired student teachers are using collaboration as inservice teachers would let teacher educators know if paired student teaching placements were “doing their job.” Some guiding research questions for such a study could be:

- How do student teachers who were paired use collaboration in their full-time teaching? What does their teaching look like?

- Are paired student teachers more comfortable giving and accepting critiques as beginning teachers?
• How do paired student teachers use reflection when they begin to teach?

Second, teacher educators are advised to try different types of collaborative student teaching placements. Brittany and Diane were both young, white, females at similar places in their teaching careers, neither having had a previous career. Studies pairing student teachers of different cultures, races, genders, and experience levels would add significant knowledge to the collaborative literature. Newell (1996) points out that collaborating with different people provides additional viewpoints and allows teachers to expand their own perspective of teaching.

In lines with the previous recommendation, a third suggestion is to place paired student teachers in a variety of school settings. Southeast High School is an upper-middle class school system with most of its graduates attending college. Further studies should focus their attention on different school settings with more diverse students.
REFERENCES


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## APPENDIX A

### TEACHING SCHEDULE

<table>
<thead>
<tr>
<th>WEEK</th>
<th>SECOND PERIOD BIOLOGY</th>
<th>FOURTH PERIOD BIOLOGY</th>
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<td>Observation</td>
<td>Observation</td>
<td>Observation</td>
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<tr>
<td>WEEK 3</td>
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<td>Team plan/teach</td>
<td>Observation</td>
</tr>
<tr>
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<td>Team plan/teach</td>
<td>Team plan/teach</td>
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<td>Diane teach</td>
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<td>WEEK 6</td>
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<td>WEEK 9</td>
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<td>WEEK 10</td>
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APPENDIX B

INTERVIEW QUESTIONS

Reflection Interview #1 Questions

1. How does having a partner influence your learning to teach specific science teaching concepts?

2. Do you think you would have learned as well without having a student teaching partner?

3. Tell me how you and your partner plan together.

4. What are some disadvantages of collaboration so far?

5. What are some advantages of collaboration?

6. How do you and your partner reflect? How does your partner help you reflect on your science teaching?

7. While giving notes, how do you divide the discussion?

8. What in your teaching contradicts your understanding about science teaching?

9. How are you working through these contradictions?

10. How does your partner help you work through these contradictions?

11. What strengths do you share with your partner? What strengths about teaching/planning does she share with you?

12. How do you split up the work you do individually?

13. Does having three people in the science classroom help by giving less work or does it sometimes add to the work by extra discussions, etc.? Are these extra discussions advantageous?

14. I have seen examples where your partner does something during teaching that is good (for example, asking inquiry questions, etc.). Do things like this make you think about how you should be teaching? Does being in a pair allow you to include items in
your teaching (examples, teaching techniques, management skills, etc.) that you may not have picked up on student teaching individually? Give me examples of this.

**Reflection Interview #2 Questions: Email**

1. How do you and your partner reflect? How does your partner help you reflect on your science teaching?

2. Can you give me some examples of your reflection and how this is allowing you to change your teaching?

3. You mentioned in your co-planning sessions that the notes for physical science haven't been working. How are you changing your teaching to make this more successful? How do you work together to make these kinds of decisions?

4. What differences have you noticed between team teaching, teaching one period alone per day, and teaching both periods alone per day?

5. I like how you are having the students do some sort of reflection each Friday. What are you learning from their responses? How are you changing your teaching due to their responses? What are some other ways you reflect with or without your student teaching partner?

6. What in your teaching contradicts your understanding about science teaching?

7. How are you working through these contradictions?

8. How does your partner help you work through these contradictions?

9. What do you do while your partner is teaching the period alone?

10. What would you like your partner to look for while you are teaching?

11. What are you learning while your partner is teaching? How is this making you reflect on your own teaching? How are you changing your teaching due to this reflection?

12. How is your partner helping you address your burning question (Brittany – assessment; Diane – teaching science to nonreaders)?

13. Are you still planning together?

**Reflection Interview #3 Questions**

1. (Brittany) How is your reflection of assessment going? Why are you giving scantron tests?
2. (Brittany) I remember last week, you and Diane went around and asked each student an individual question, and this week, you asked the questions to the lab groups. How are you changing your review sessions in physical science?

3. How is your partner helping you plan?

4. How are you reflecting on your science teaching? How is your partner helping you reflect?

5. What are you reflecting on (science content, teaching methods, students, discipline and management)?

6. Do you collaborate on anything during teaching now that you are teaching and planning alone?

7. What kinds of suggestions do you make for your partner? What kinds of suggestions does your partner make for you?

8. (Diane) How is your teaching science to nonreaders going?

9. How do you use Friday’s student reflection to adjust your teaching?

10. (Diane) How do you feel about the decision to let students choose whether to go over the notes together first or work on them on their own? Do you think it made the discussion go better? Do you think they learned more? Would you do this again?

**Final Interview Questions: Email**

1. Tell me about your overall experience being paired during student teaching.
   a. What did you learn from your student teaching partner?
   b. How did having a partner influence your science teaching?
   c. What was the best part about having a student teaching partner?
   d. What would you change about the experience?
   e. Is there anything else you would like to add about your collaborative student teaching experience?

2. If you were to design a collaborative student teaching placement, what would it look like? In other words, what elements of your experience this semester would you use, change, etc.?

3. Do you feel that you have benefited (become a better science teacher) because of your partner? How so?

4. What was the role of your student teaching partner in your science teaching?
5. What was the role of your cooperating teachers in your collaborative science teaching?

6. Please feel free here to give me any other experiences that you feel would be beneficial to me about your student teaching experience.
APPENDIX C

COMPLETE CODING SCHEME FOR RESEARCH DATA

Category: Division of Teaching Responsibilities

A. Division of teaching responsibilities
   1. Administrative issues
   2. Science content preparation
   3. Teaching

B. Where teaching responsibilities were divided
   1. During teaching
   2. At school but not during class
   3. Outside of school

C. Two approaches for dividing teaching responsibilities
   1. Working separately on the same concept
   2. Working separately on different concepts

Category: Giving Two Explanations

A. Explaining content

B. Giving directions

C. Answering questions

D. Disciplining students

Category: Triggers for Reflection

A. Dilemmas
   1. Presentation of biology notes
   2. Presentation of physical science notes

B. Student feedback
   1. Written comments
   2. Responses during class
Category: Evidence of Growth Through Reflection

A. Growth in management
   1. Student discipline
   2. Obtaining students’ attention
   3. Student engagement in science lesson

B. Growth in science content

C. Growth in pedagogical content knowledge
   1. Designing science activities
   2. Using analogies
   3. Synthesizing the science content
   4. Sequencing the order of the lesson

Category: Mechanisms of Reflection

A. Knowledge base for reflection
   1. Planning activities
   2. Learning strategies
   3. Self-understanding of the science content

B. Suggestions

C. Tensions

D. Support