Supporting Academic Language Development in Elementary Science: A Classroom Teaching Experiment

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Dedication

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Abstract

Academic language is the language that students must engage in while participating in the teaching and learning that takes place in school (Schleppegrell, 2012) and science as a content area presents specific challenges and opportunities for students to engage with language (Buxton & Lee, 2014; Gee, 2005). In order for students to engage authentically and fully in the science learning that will take place in their classrooms, it is important that they develop their abilities to use science academic language (National Research Council, 2012). For this to occur, teachers must provide support to their students in developing the science academic language they will encounter in their classrooms. Unfortunately, this type of support remains a challenge for many teachers (Baecher, Farnsworth, & Ediger, 2014; Bigelow, 2010; Fisher & Frey, 2010) and teachers must receive professional development that supports their abilities to provide instruction that supports and scaffolds students' science academic language use and development.

This study investigates an elementary science teacher's engagement in an instructional coaching partnership to explore how that teacher planned and implemented scaffolds for science academic language. Using a theoretical framework that combines the literature on scaffolding (Bunch, Walqui, & Kibler, 2015; Gibbons, 2015; Sharpe, 2001/2006) and instructional coaching (Knight, 2007/2009), this study sought to understand how an elementary science teacher plans and implements scaffolds for science academic language, and the resources that assisted the teacher in planning those scaffolds. The overarching goal of this work is to understand how elementary science teachers can scaffold language in their classroom, and how they can be supported in that

work. Using a classroom teaching experiment methodology (Cobb, 2000) and constructivist grounded theory methods (Charmaz, 2014) for analysis, this study examined coaching conversations and classroom instruction to identify and understand what scaffolds are planned and implemented, and how that planning and implementation occurred through an instructional coaching partnership.

Findings from this study showed the elementary science teacher planned and implemented a number of scaffolds for science academic language, focusing primarily on the use of sentence starters as a scaffolding strategy. The findings also indicated that the instructional coaching partnership played a vital role as the main resource that assisted the planning of scaffolds. These findings provide insights into the types of scaffolds that elementary science teachers can implement to scaffold science academic language, and the role that instructional coaching can play in supporting teachers as they work to provide instruction that scaffolds their students' language use and development.

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Chapter 1: Introduction

The development of the *Next Generation Science Standards* (NGSS) has increased the depth of science learning that is expected from students, with students needing to make connections across the science and engineering practices, and use those practices when learning the crosscutting concepts and disciplinary core ideas (Buxton & Lee, 2014). This increased depth will be more cognitively demanding on students as the NGSS expects all students to develop the knowledge and thinking skills within the standards (Buxton & Lee, 2014). With this increased depth in science learning, there will also be an increase in the language demands needed when engaging with the science content and practices in the NGSS (Lee, Miller, & Januszyk, 2014). Students will need to read complex science texts, write in a range of formats that are specific to science, and engage in oral discussions in which they present arguments that are supported with evidence and reasoning (Lee, Quinn, & Valdes, 2013). In order for students to fully and authentically participate in learning the science content and practices, it is important that they are supported in developing the types of language used in science (National Research Council [NRC], 2012).

However, for many students using language in the science classroom to read, write, and talk about science concepts means that students must use language in ways that are different from how they use language in other settings. The ways that students are asked to read, write and speak in the science classroom includes unique structures for describing and explaining relationships, procedures, or abstract ideas, that differ from everyday language, while simultaneously requiring a high number of technical and specialized vocabulary terms (Zwiers, 2014). In the most recent science education reform

report, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* [hereafter referred to as The Framework] (NRC, 2012), from which the NGSS were developed, the NRC acknowledges the important role that language plays in student learning of science:

> Any education in science and engineering needs to develop students' ability to read and produce domain-specific text. As such, every science or engineering lesson is in part a language lesson, particularly reading and producing the genres of texts that are intrinsic to science and engineering. (p. 76)

Students need opportunities to practice and develop their abilities in reading, writing, and speaking the language needed to communicate scientific reasoning and understanding. They must develop understanding of not only the technical terms that are highly prevalent in science content, but also the academic language that is frequently not a part of students' everyday language (NRC, 2012).

Academic language includes the language that is used in schools for teaching and learning (Schleppegrell, 2004), is functional for accomplishing tasks in schools (Anstrom et al., 2010; Schleppegrell, 2012), and varies across different subjects and content areas (Zwiers, 2014). It has been shown to emerge in students at a very young age (Scheele, Leseman, Mayo, & Elbers, 2012), and students from low-socio-economic backgrounds, English language learners (ELLs), and students of color often face the biggest differences between their home and everyday language and the language used in schools (Delpit, 2006; Michaels, 1981). In contrast, native English speakers and middle- to upper-socioeconomic classes are often unintentionally schooled into the ways in which language is used in classrooms (Gee, 2008). Therefore, it is important that elementary

teachers support all of their students in developing the academic language needed for science learning, and do so in ways that build off the linguistic resources the students bring to the classroom (Lee & Fradd, 1998).

The focus on academic language is increasing in today's classrooms, teacher preparation programs, and standards (Ranney, 2012), however it remains an area of challenge for many teachers (Baecher, Farnsworth, & Ediger, 2014; Bigelow, 2010; Fisher & Frey, 2010). Teachers may struggle to make their language expectations clear to their students, may not be aware of the implicit expectations they have for language, or face challenges in understanding student ideas when those ideas are presented in language that differs from the expected language use (Schleppegrell, 2012). For in-service teachers, it is particularly important that they receive professional development opportunities to continue the development of their knowledge and skills related to academic language as our schools are becoming increasingly diverse, with growing populations of ELLs in our schools (Buxton & Lee, 2014; DiCerbo, Anstrom, Baker, & Rivera, 2014). The research examining the effect of professional development programs on teachers' knowledge and skills related to academic language is limited, with even fewer studies examining the development of science teachers (Buxton & Lee, 2014; DiCerbo et al., 2014). Therefore, a study that examines the development of an elementary science teacher in his ability to plan and implement academic language instructional activities is warranted.

Purpose

This study explores the ways in which an elementary science teacher engages with the process of planning and implementing academic language supports, while

participating in an instructional coaching partnership. It seeks to provide insights into the following areas: 1) The process of planning scaffolds for science academic language by an elementary science classroom teacher, 2) The ways in which planned scaffolds for science academic language are implemented, and 3) The types of resources that assist an elementary science teacher in successfully planning scaffolds for science academic language.

Research Questions

This qualitative research study aims to answer the following questions related to the planning and implementation of academic language instructional materials and supports, to explore the experience of the classroom teacher:

1) What actions and processes does an elementary science teacher engage in while planning instruction that scaffolds science academic language?
    a. What resources assisted the teacher in planning scaffolds for science academic language?
2) What actions and processes does an elementary science teacher engage in while implementing instruction that scaffolds science academic language?

Overview of the Following Chapters

Chapter 2 provides a review of the relevant literature which has guided this study, and focuses on academic language, academic language in science classrooms, teacher development in supporting academic language, and professional development for science teachers that has focused on academic language. It will also present the theoretical framework that guided this study, describing both scaffolding of science academic language as well as coaching and reflective practice. Chapter 3 describes and explains the

methodology that was used in this study, by first describing the research design, context and participant. It then describes the data collected for this study and the qualitative methods used for analysis. Chapter 4 explains the findings of the study, which present the actions and processes engaged in through a teacher's planning and implementing of scaffolds for science academic language, and the resources that assisted that teacher's planning of scaffolds. The final chapter, Chapter 5, summarizes the findings by discussing conclusions, challenges and implications of this work before suggesting how the findings can be extended into future research directions.

Chapter 2: Literature Review

This chapter provides a review of the literature that lays the foundation for the study. I begin by presenting some of the different conceptions of academic language, followed by a focus on the specifics of science academic language. I then discuss the different ways in which professional development designed to build teacher knowledge and skills around academic language has occurred both in education broadly, as well as specifically for science teachers. Following this review of the literature I present the theoretical framework that guided this study. This framework draws on the concept of scaffolding (Bunch, Walqui, & Kibler, 2015; Gibbons, 2015; Sharpe, 2001) and posits that instructional coaching partnerships (Knight, 2007/2009) can support teachers in developing scaffolds that will support students in using and developing science academic language.

Academic Language

Broadly speaking, academic language is the language of schooling and includes the ways in which teachers and students read, write and speak in classrooms (Schleppegrell, 2004). This language is functional for accomplishing tasks in schools, and includes features not found in everyday, conversational language (Schleppegrell, 2012). Academic language varies across classroom settings and disciplines, and extends beyond the classroom as students will use it throughout their lives to "describe complex ideas, higher-order thinking processes, and abstract concepts" (Zwiers, 2014, p. 22). However, a number of scholars (Anstrom et al., 2010; DiCerbo et al., 2014; Ranney, 2012) have noted that academic language (also referred to as academic English) is conceptualized, defined and operationalized in a number of different ways. In the following sections I

present three ways in which academic language has been conceptualized and defined which have guided my understanding of academic language in elementary classrooms.

One of the first definitions of academic language came out of the work of Jim Cummins. In his work, he distinguished between the language students use in their everyday conversations and the language they use when engaging in school (Cummins, 1980). Cummins (1980) called the everyday language students used Basic Interpersonal Conversation Skills (BICS), and referred to the language students used in schools as Cognitive Academic Language Proficiency (CALP). BICS was thought of as more of a social language, in which students would rely heavily on contextual cues and short back-and-forth interpersonal interactions when sharing ideas. CALP on the other hand, was defined as language that was more cognitively demanding and relied much less on the short back-and-forth interpersonal interactions that provide contextual clues, with students instead taking longer turns to expand on an idea (DiCerbo et al., 2014). Cummins (2000) then modified this notion of BICS and CALP to present a four-quadrant model of language. In this model, language falls in one of four categories: 1) language that is high in context but at a low level of cognitive demand (e.g., ordering food at a restaurant), 2) language that is high in context and at a high level of cognitive demand (e.g., participating in a discussion about the science concepts while engaging in a lab activity), 3) language that is low in context and at a low level of cognitive demand (e.g., reading a letter/email from a friend or family member), and 4) language that is low in context but at a high level of cognitive demand (e.g., taking a standardized science content test). Categories #1 and #3 (ordering food and reading an email) would be more

characteristic of BICS, whereas categories #2 and #4 (a science discussion and taking a standardized test) would be more characteristic of CALP.

A second conceptualization of academic language came from Dutro and Moran (2003). In this model, Dutro and Moran advocated that teachers analyze and examine the language demands on their students to provide instructional activities and supports that help their students in developing language. They posit that teachers should use knowledge of their students when examining the language their students will need in the lessons, and then identify opportunities for meaningful, contextualized language development to increase proficiency. Dutro and Moran (2003) noted that vocabulary and language forms (described below) should be frontloaded to support students in comprehending and producing the language necessary, and that teachers should maximize teachable moments to build on the language students are using within lessons.

Dutro and Moran (2003) identified three components which they believe teachers should focus on when planning instruction: function, form and fluency. They defined functions as the tasks or purposes for which language is used, and note that students need instruction into how to use language for different purposes. Language functions can include "navigating written text, asking and answering informational and clarifying questions, relating information, comparing and contrasting, explaining cause and effect, drawing conclusions, summarizing, evaluating, justifying, persuading, and conducting research" (Dutro & Moran, 2003, p. 233). As students progress in their learning, the language the students use with different functions will increase in complexity. For example, with the function of describing, as a student might begin with simple one-word statements (e.g. "brown" or "bear"), progress into simple complete sentences ("The bear

is brown."), and finally moving into more complex statements ("The brown bear has thick fur and sharp claws.") (Dutro & Moran, 2003, p. 234).

Forms are defined as the grammatical and syntactic features of language that are necessary for students to engage in reading, writing and speaking. These forms are the tools that allow students to structure language into complex ideas and includes items such as parts of speech, verb tenses, pronouns, conjunctions and sentence structures (Dutro & Moran, 2003). Dutro and Moran (2003) noted that a strong understanding of form allows students to make sense of the language they encounter in schools and participate fully in content as proficient speakers, readers, and writers. Dutro and Moran (2003) referred to fluency as the ease and automaticity with which students are able to comprehend and produce academic language functions and forms. They believe that fluency is developed "through focused and deliberate engagement with a range of uses of language" (Dutro & Moran, 2003, p. 242).

The third conceptualization of academic language was presented by Scarcella (2003). In this framework, Scarcella (2003) presented a broader view of academic language, and focused on three main dimensions: the linguistic dimension, the cognitive dimension, and the sociocultural/psychological dimension. The linguistic dimension of the framework includes the reading, writing, speaking and listening skills that students need in order to engage with academic language. This dimension, which is similar to Dutro and Moran's (2003) notion of functions, forms, and fluency, consists of multiple components, including: phonological, lexical, grammatical, sociolinguistic, and discourse (Scarcella, 2003). Table 2.1 provides a brief overview of each of these components and

the linguistic features of academic language necessary for academic language proficiency.

Table 2.1

Linguistic components of Academic Language from Scarcella (2003)

Component	Linguistic features
Phonological	Knowledge of the phonological features of academic language, including stress, intonation, and sound patterns.
Lexical	Knowledge of general words used across disciplines and in everyday situations, technical words used in specific subject areas, nontechnical words used across subject areas.
Grammatical	Knowledge of grammatical features, both from everyday language, as well as the grammatical structures that are specific to academic language and different subject areas.
Sociolinguistic	Knowledge of language functions beyond those commonly used in everyday language such as cause and effect, hypothesizing, generalizing, comparing, contrasting, and evaluating.
Discourse	Knowledge of how to use linguistic forms and meanings to communicate clearly and in ways that are specific to different subject areas.

Engaging with academic language requires more than just the linguistic dimension and components, but also requires cognition. Thus, the second dimension of Scarcella's (2003) framework, the cognitive dimension, focused on student knowledge, higher order thinking, critical literacy skills, and the cognitive and metalinguistic strategies that students need when engaging with academic language. As students engage in academic language, they use their prior knowledge to make sense of information and "fill gaps in communication or interpret ambiguous messages" (Scarcella, 2003, p. 22). Using and developing higher order thinking and critical literacy skills are central to engaging with and developing academic language as students will need to interpret, evaluate, and synthesize information when listening and reading, or combine information to formulate clear and convincing arguments and ideas when writing and speaking

(Scarcella, 2003). Finally, within the cognitive dimension of the framework, Scarcella (2003) called for a need to teach cognitive and metalinguistic strategies that can support students in effectively communicating, in overcoming instances where communication breaks down, and in editing and revising their language use to allow for improved communication and performance.

The third dimension of Scarcella's (2003) framework examined the sociocultural/psychological aspects of academic language. Academic language, and the ways in which language is used in school settings, comes not only out of the specific linguistic forms and cognitive resources, but also from the social practices that are associated with schools and different subject areas that drive how language is used (Scarcella, 2003). Scarcella (2003) connects academic language to Vygotsky's (1978/1986) work on the role of social interaction in cognitive development, noting that "academic English is created by individuals within a speech community and is shared and changed by these individuals" (Scarcella, 2003, p. 29). As such, if students are to acquire academic language they will need to also acquire the norms, beliefs, values, attitudes, and conventions that are associated with the specific contexts in which academic language is being used. For example, when engaging in a science investigation, there are certain ways that students might be expected to share their reasoning for why something happened, by including "references to evidence and…distinguish[ing] evidence from opinion" (NRC, 2012, p. 73), which will require students to use technical vocabulary terms and highly specific language.

These three frameworks have guided my understanding of academic language, and its use and development in elementary classrooms by highlighting the multiple

components present in academic language and how students engage with those multiple components in the classroom. Specifically, these frameworks have highlighted the unique ways in which students are expected to engage with and use language in the different content areas, and that for many students these unique ways of using language present challenges. The following section addresses the literature around the unique ways in which academic language is used in science, and the challenges that this science academic language can present to students.

Academic language in science. Academic language exists across the subject areas found in schools but perhaps no subject places higher demands for its use than science. As Gee (2005) notes:

> No domain represents academic sorts of language better than science. Science makes demands on students to use language, orally and in print, as well as other sorts of symbol systems, that epitomize the sorts of representational systems and practices that are at the heart of school success. (p.19)

Science and language are inextricably linked (Lemke, 1990), with science teaching and learning requiring students to describe relationships, comparisons, cause and effect, hypotheses and procedures using very explicit language and a high number of technical terms (Zwiers, 2014). At the same time, reading within science classrooms requires that students navigate very dense text that include features such as passive voice and nominalizations which are frequently not found in everyday conversations (Zwiers, 2014). In addition to the linguistic features of science language, participating in science classrooms also includes the "dispositions, behaviors, critical language arts skills, higher

order thinking, and metalinguistic knowledge needed to understand scientific concepts" (Tong et al., 2014, p. 2084).

The academic language used in science classrooms can be very challenging for students as it often differs significantly from the ways in which they use language in everyday situations (Gee, 2008). In everyday situations, interactions frequently include a high amount of back and forth between speakers with shorter turns and truncated language, in which speakers are co-constructing meaning through shared experience (Gee, 2005). Academic language on the other hand, often times requires students to take longer turns, expanding on a single idea, and to describe things that are not immediately in front of them. Lemke (1990) notes that this can be particularly prevalent in science and causes oral language to more closely resemble written language, with a high level of explicitness and technical vocabulary that many students do not know. Gibbons' (2003) work on mode continuums highlights how elementary science language changes as the students produce language away from the immediate context. She presents an example of students engaging with an activity to determine what metals a magnet attracts. As students progress from discussing in a small group to writing an encyclopedia entry, the students' language includes more information, becomes more lexically dense, and more impersonal (Gibbons ,2003). Table 2.2 provides this continuum of elementary science language.

Table 2.2

Mode contiuum of elementary science language.(Modified from Gibbons, 2003, p. 252)

Context	Text
Small group discussion	"Look it's making them move. Those don't stick."
Student sharing with teacher	"We found out the pins stuck on the magnet."
Student written response	"Our experiment showed that magnets attract some metals."

Student encyclopedia entry	"Magnetic attraction occurs only between ferrous metals."

While it is important for students to be building on the language they bring to schools, Gee (2008) notes that everyday language can at times create challenges within the science classroom. He presents the following example of two students discussing what occurred in an experiment examining what makes things rust:

> Jill: But if we didn't put the metal things on there, it wouldn't be all rusty.
>
> Philip: But if we didn't but the water on there, it wouldn't be all rusty.
>
> (Gee, 2008, p. 57)

In this example, the students have both used the same everyday phrase "all rusty", however the students are communicating two very different ideas. Jill is referring to how the rust has come off the bottle caps ("metal things") and onto the plate, whereas Philip is referring to how the water caused the bottle cap to become rusted (Gee, 2008). Gee (2008) notes that it is important for teachers to understand the distinctions between everyday language and science academic language so they can support students in acquiring the academic language needed to engage with the content and clearly communicate their thinking and understanding.

As students engage with science content and acquire the academic language needed for that content, the language that teachers use in their classrooms will play a vital role in both the students' content and language learning. Butler, Stevens, and Lord (2007) sought to characterize the oral academic language that was used by elementary teachers within elementary classrooms by analyzing teacher talk during 4th and 5th grade science lessons. In their analysis, Bailey et al. (2007) identified four language functions used by

the elementary teachers that were highly prevalent within the science lessons: explanation, description, comparison and assessment. These functions were found throughout instruction and were used to communicate specific science content information and introduce new vocabulary terms to the students (Bailey et al., 2007). As an example, Bailey et al. (2007) found that explanation was used by the teachers to "demonstrate scientific relationships, make scientific concepts understandable, and give reasons for scientific theories and experiments" (p.119). They provide the following example of how one teacher used this language function when talking to the students to demonstrate scientific relationships: "Does it have a mutualistic relationship? The clown fish will actually protect the sea anemone. That's a mutualistic relationship" (p.119). Bailey et al. (2007) found that students were required to attend to multiple functions during lessons, and concluded that it would be important for teachers to use "effective communicative strategies for teaching/reinforcing academic language" (p.125).

Lee, Quinn, and Valdés (2013) examined connections between the science and engineering practices laid out in *A Framework for K-12 Science Education* (NRC, 2012), and the language that students would be required to use to engage with those practices. Their analysis focused on four of the eight specific science and engineering practices: developing and using models, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information as they felt these practices were interrelated, language intensive, the least familiar for science teachers, and required classroom discourse and norms that are common across science disciplines (Lee et al., 2013). In analyzing these science and engineering practices, Lee et al. (2013) found that each of these practices included

receptive (listening/reading) and productive (speaking/writing) language that students would be required to use while engaging with each practice. Table 2.2 provides an overview of each practice, and the receptive and productive language that Lee et al. (2013) found through their analysis.

Table 2.3

Language Associated with the Science and Engineering Practices from Lee et al. (2013)

Science and engineering practice	Receptive language	Productive language
Develop and use models	Comprehend others' oral and written descriptions, discussions, and justifications of models of phenomena or systems. Interpret the meaning of models presented in texts and diagrams.	Communicate (orally and in writing) ideas, concepts, and information related to a model for a phenomenon or system. Label diagrams of a model and make lists of parts. Describe a model using oral and/or written language as well as illustrations. Describe how a model relates to a phenomenon or system. Discuss limitations of a model. Ask questions about others' models.
Develop explanations and design solutions	Comprehend questions and critiques. Comprehend explanations offered by others. Comprehend explanations offered by texts. Coordinate texts and representations.	Communicate (orally and in writing) ideas, concepts, and information related to an explanation of a phenomenon or system (natural or designed). Provide information needed by listeners or readers. Respond to questions by amplifying explanation. Respond to critiques by countering with further explanation or by accepting as needing further thought. Critique or support explanations or designs offered by others.

Engage in argument from evidence	Comprehend arguments made by others orally. Comprehend arguments made by others in writing.	Communicate (orally and in writing) ideas, concepts, and information related to the formation, defense, and critique of arguments. Structure and order written or verbal arguments for a position. Select and present key evidence to support or refute claims. Question or critique arguments of others.
Obtain, evaluate, and communicate scientific information	Read or listen to obtain scientific information from diverse sources including lab or equipment manuals, oral and written presentations of other students, Internet materials, textbooks, science-oriented trade books, and science press articles. Listen to and understand questions or ideas of others.	Communicate (orally and in writing) ideas, concepts, and information related to scientific information. Present information, explanations, or arguments to others. Formulate clarification questions about scientific information. Provide summaries of appropriate information obtained for a specific purpose or audience. Discuss the quality of scientific information obtained from text sources based on investigating the scientific reputation of the source, and comparing information from multiple sources.

The authors note that these practices will be language intensive for students, presenting both language demands and challenges, and that teachers will play an important role "to encourage and support language use and development in the service of making sense of science" (Lee et al., 2013, p. 231). This analysis highlights the important role that language plays in the science classroom, and underscores the importance of teachers' supporting this language, and the present study sought to build on this research by understanding how an elementary science teacher scaffolded the language his students encountered in the classroom.

Teacher Development in Supporting Academic Language

In order for students to develop the academic language necessary to participate in school and in science classrooms, teachers must provide instruction that supports this development. Unfortunately, providing this type of support is an area in which many teachers often struggle (Schleppegrell, 2012). Many teachers struggle to see and articulate the language demands of their lessons, failing to make explicit to their students the language the students are expected to use (Schleppegrell, 2004/2012). Fillmore and Snow (2002) contend that teachers must understand how language works in order to be able to select learning materials and activities that will provide students with opportunities for language development, and receive education and professional development to support this understanding. Professional development opportunities that focuses on academic language can support teachers in this understanding, however, Buxton and Lee (2014) note that "despite the growing awareness of the need to address issues of linguistic diversity, including the needs of ELs [English learners], limited progress has been made in preparing teachers to succeed in today's culturally and linguistically diverse classrooms" (p.215).

While supporting academic language is becoming an increasing part of pre-service teacher preparation programs, in-service teachers must participate in professional development in order to develop their abilities to support their students in academic language development (Téllez & Waxman, 2004). Research has shown that professional development for in-service teachers on academic language needs to balance knowledge development and practical application (Aguirre-Munoz, Parks, Benner, Amabisca, & Boscardin, 2006; DiCerbo et al., 2014; O'Hara, Pritchard, Huang, & Pella, 2013). These

programs should support teachers in developing their knowledge and understanding of academic language, to allow them to identify ways to support their students in its use (DiCerbo et al., 2014; O'Hara et al., 2013), while also focusing on specific, practical strategies that can be implemented within the specific content areas that teachers are teaching (Aguirre-Munoz et al., 2006; O'Hara et al., 2013; Townsend, 2015). The following section will review the literature on professional development focused on developing science teachers' knowledge and practice for supporting academic language.

Professional development for science teacher knowledge and practice in supporting academic language. In their chapter on "English Learners in Science Education" from the *Handbook of Research on Science Education*, Buxton and Lee (2014) note that "A limited number of studies have addressed professional development efforts to help in-service teachers effectively integrate science learning with English language development" (p.216), with few examining the ways in which science teachers engage in planning and implementing supports for academic language in science classrooms. While this study does not directly evaluate the effectiveness of instructional coaching as a professional development approach for supporting teachers' integration of science and language instruction, it does add to this literature by examining how an elementary science teacher plans and implements scaffolds for science academic language while engaging in an instructional coaching partnership.

Three studies have examined the effects of professional development on science teacher language supports. The study by Hart and Lee (2003) examined the impact of an instructional intervention on the beliefs and practices of elementary teachers in regards to integrating English language development and literacy with science instruction. In this

study, they worked with fifty-three 3rd and 4th grade teachers over the course of one school year, during which time the teachers implemented two instructional units that were developed specifically for the project, as well as participated in four workshops focused on engaging students in inquiry science while integrating English language and literacy (Hart & Lee, 2003). Of these four workshops, the second workshop focused most explicitly on supporting language and literacy into specific science lessons. In this workshop, the project personnel and teachers focused on, and examined, different strategies for reading and writing development in science, which included writing paragraphs to describe scientific processes, writing narrative stories based on science concepts, and strategies for engaging in whole group, small group, and individual science reading. Linguistic scaffolding was another topic that was covered significantly in this workshop. This included ways for teachers to adjust the level of their verbal, written, graphic and gestural communication to allow for enhanced scientific understanding by their students (Hart & Lee, 2003). Following these discussions of different strategies for language and literacy integration, the teachers examined the second instructional unit to identify specific areas and ways that language and literacy activities could be incorporated into science instruction.

To examine how teacher practices changed as a result of the professional development workshops, observations of the teachers were completed twice for each teacher, once in the fall and once in the spring. Observations were completed using a 5-point Likert observation scale that was designed by the project to examine the following three criteria ("Conventions of Language and Literacy" was not numerically rated but used to guide the descriptions of the classrooms):

1. Reading and Writing in the Context of Science—To what extent does the teacher promote literacy (reading and writing) activities in the science lesson?
2. Linguistic Scaffolding to Enhance Science Meaning—To what extent does the teacher tailor his or her communication (verbal, gestural, written, graphic) to enhance students' understanding of science?
3. Conventions of Language and Literacy—To what extent does the teacher monitor students' use of grammatical and graphic conventions to enhance students' use of standard English (oral and written)? (Hart & Lee, 2003, p. 486)

The ratings between the fall and spring observations were analyzed using dependent t-tests and Cohen's d effect sizes. The results of the analysis showed no statistically significant change in the reading and writing practices of the teachers. However, there was a statistically significant increase in the amount of linguistic scaffolding that the teachers provided to their students (Hart & Lee, 2003), indicating that professional development which includes a focus on linguistic scaffolding in science can influence use of scaffolds by elementary teachers.

Studies conducted by Lee and colleagues (Lee et al., 2016; Lee & Maerten-Rivera, 2012) expanded on the work of Hart and Lee (2003) examining teacher development after participating in longitudinal professional development. Both studies examined teacher development of knowledge and practices in teaching science to ELL students after participation in a multiyear professional development, in which teachers engaged in workshops that focused on inquiry science teaching and English language development practices. In both cases, teachers completed a questionnaire to self-report their teaching practices. The questionnaire used by Lee and Maerten-Rivera (2012) asked

teachers to report their teaching practices related to 1) teacher knowledge of science content, 2) teaching practices to promote scientific understanding, 3) teaching practices to promote scientific inquiry, and 4) teaching practices to support English language development. Following this study, Lee et al. (2016) used a refined version of this questionnaire that examined teaching practices related to 1) promoting students' scientific understanding, 2) promoting students' scientific inquiry, 3) supporting language development, and 4) incorporating ELLs home language. In both cases, the researchers found that over the course of participation in the professional development there was statistically significant positive changes in English language development (Lee & Maerten-Rivera, 2012) and supporting language development (Lee et al., 2016).

Overall, the understanding of the ways in which professional development programs can increase teachers' knowledge and skills in supporting academic language is just beginning. As DiCerbo et al. (2014) note, "Research on professional development in AE [academic English] is in its infancy" (p.472) but that engaging in high-quality professional development can improve teachers' knowledge and skills. There is also a limited amount of research that looks specifically at academic language development in the elementary science contexts with mainstream teachers (Buxton & Lee, 2014). DiCerbo et al. (2014) and Buxton and Lee (2014) call for continued research on professional development that supports teachers' academic language knowledge and skills, and this study aimed to add to this body of research by examining how an elementary science teacher developed his abilities to plan for and support academic language through engaging in an instructional coaching professional development.

Theoretical Framework

All elementary students will engage with academic language from the beginning of their time at school and in science classrooms. In order for students to be successful in using and developing the science academic language necessary to engage with the science and engineering practices, teachers must provide instruction that supports students' language (Buxton & Lee, 2014). If elementary teachers are to provide this instruction, they must connect what they know about science, language, and the language their students bring to the classroom. The research presented here focuses on an elementary science teacher for this reason, to understand how his knowledge and practice is applied and developed to support student language use. The theoretical perspective that guided this study combines the concept of scaffolding with Knight's (2007) instructional coaching partnerships and York-Barr, Sommers, Ghere, and Montie's (2006) work on reflective practice. In the sections below, I present each of these perspectives and describe how they were combined to guide this study.

Scaffolding science academic language. If students are to use the science academic language found in elementary classrooms, it is important that they are supported in developing this language through the instruction they receive in the classroom. One means to support this development is through the use of scaffolds. Scaffolding is a common concept discussed in educational settings, and has been widely applied and researched in the teaching and learning of academic language with English language learners (Sharpe, 2006). This study is not focused specifically on supporting English language learners, however, the findings from the work that has been done in ELL settings are informative for the teaching of academic language to all students in

elementary classrooms. As discussed above, academic language poses challenge to a broader range of students in today's classrooms, all of whom need support in using and developing science academic language.

The basic premise of scaffolding language is much like how scaffolding is used in at a construction site; a temporary structure is setup to allow someone to reach something they would not otherwise be able to reach. Similarly, for students learning academic language, teachers can provide scaffolds that support students in the language they are using and learning each day in the classroom, language they might otherwise struggle to use (Gibbons, 2015). The basis for scaffolding comes from Vygotsky's (1978/1986) "zone of proximal development" (ZPD), which posits that a learner can, with the support of a more knowledgeable other, achieve learning that they would not otherwise be able to attain. Vygotsky defined ZPD as:

> It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p. 86)

Much like the scaffolds used at a construction site, the scaffolds provided to support science academic language development should be temporary, with the support being gradually removed as students gain independence with the language (Zwiers, 2014). Supports must be provided to students that scaffold not only the language of that moment, but also provide skills and learning that will be useful in the future in completing a similar language task (Bunch et al., 2015; Gibbons, 2015).

Scaffolds for academic language can take one of two forms, designed-in or point-of-need (Sharpe, 2001). Designed-in scaffolds are those scaffolds that teachers prepare prior to the beginning of their lessons, and provide support for the language that teachers know their students will engage with during the lessons (Sharpe, 2006). These scaffolds are developed during the design of units and lessons, and take into account teachers' goals, their understanding of the language demands in their lessons, and their knowledge of their students (Sharpe, 2006). In contrast to these designed-in scaffolds, teachers will also need to provide point-of-need scaffolds (Sharpe, 2001). No matter how purposefully and thoughtfully a lesson is designed, opportunities "will arise for the teacher to take the students along a particular path in their thinking which helps them establish key concepts or ideas" (Sharpe, 2001, p. 36). In these moments, teachers can use a variety of strategies, such as questioning, recasting, relating student ideas to previous experiences, and multimodal strategies, that will support the students in developing their understanding, while also supporting their use and development of academic language (Sharpe, 2006). In order for point-of-need scaffolds to be provided to students, it is contingent upon teachers to identify both the moment in which students need support, as well as a strategy that can be applied to support that in the moment language use.

In order for elementary science teachers to successfully design-in scaffolds, as well as identify opportunities to provide point-of-need scaffolds, it is important that they have knowledge of science academic language as well as skills and strategies they can utilize to scaffold science academic language. If in-service teachers are to develop their knowledge and skills in supporting academic language, it will likely come through engaging in professional development experiences, and instructional coaching and

reflective practice partnerships may serve as a means to provide this professional development for in-service teachers.

Coaching and reflective practice. Coaching is one approach that may be able to provide the type of focused professional development that can support elementary science teachers in developing their knowledge and skills in academic language, as coaching has been shown to impact teacher attitudes, teacher practice, teacher efficacy, and student achievement (Cornett & Knight, 2009). This study used a blend of instructional coaching and reflective practice to do just this, and thus an examination of coaching is warranted. The following sections define and examine the features of instructional coaching, the ways it has been used in science classrooms, and explore the opportunities it presents in supporting elementary science teachers in developing their knowledge and skills in academic language.

Instructional coaching and reflective practice. Instructional coaching is a practice in which a teacher engages with an instructional coach to focus on improving instruction and incorporating research-based instructional strategies (Knight, 2007). Coaches bring expertise to the partnership to support the teacher in developing instructional practices (Teemant, 2014) however the goal is not for the instructional coach to enter the classroom and tell the teacher what he/she must do. Instructional coaching is built on partnership and is characterized by seven principles: *equality*, *choice*, *voice*, *dialogue*, *reflection*, *praxis*, and *reciprocity* (Knight, 2007). Without maintaining these partnership principles, instructional coaches may create spaces in which the teachers they work with are resistant to the ideas and perspectives the coaches bring to

their work. Table 2.3 provides an overview of these seven partnership principles and how I have defined them for the purposes of this study.

Table 2.4

Knight's (2007) Partnership Principles

Partnership Principle	Overview of principle
Equality	"Instructional coaches and teachers are equal partners" (p.40). Instructional coaches and teachers must engage in their work as equals. Each person's beliefs, thoughts and views should be held in equal standing, with no one person's ideas being more important or valued. This does not mean that coaches and teachers need to have equal knowledge or skills, but that both the opinions and points of view of each are worth hearing while engaging in their work together.
Choice	"Teachers should have choice regarding what and how they learn" (p. 41). In an instructional coaching partnership, one person does not make decisions for the other. Because each partner is equal, choices and decisions are reached collaboratively. True partners also make the choice to engage in the work together, and teachers should have choice of what skills and strategies they choose to implement. Coaches can use their knowledge to provide multiple potential skills and strategies that teachers can choose from.
Voice	"Professional learning should empower and respect the voices of teachers" (p. 43). Both instructional coaches and teachers engaging in partnerships must be free to speak their mind, and share their perspectives and points of view. Coaches must value the opinions of the teachers they collaborate with, even when they disagree with those teachers. Doing so allows teachers to know they are free to share their perspectives on the content being learned and the instructional strategies being discussed.
Dialogue	"Professional learning should enable authentic dialogue" (p. 46). While engaging in conversations that encourage each to speak their minds, instructional coaches and teachers must also listen authentically and fully to completely understand what the other is saying. Instructional coaches must listen more than they talk, and avoid manipulating the conversation toward certain perspectives. Dialogue is meant to open up discussion and ideas, and allow coaches and teachers to think and learn together.
Reflection	"Reflection is an integral part of professional learning" (p. 47). As teachers engage in partnership work, one of the most important aspects will be how those teachers choose to make sense of the information they are learning. Teachers need time to reflect on and consider the choices they are provided, and be free to accept, reject or modify those choices. Instructional coaches can support this reflection by providing time and space for the teachers they work with to reflect on ideas before adopting them.
Praxis	"Teachers should apply their learning to their real-life practice as they are learning" (p. 49). Instructional coaching partnerships should be centered around the opportunity for teachers to put the ideas they are discussing and learning into practice. Teachers need to have the opportunity to reconstruct and use the learning as they see most useful, and therefore instructional coaches and the teachers they work with focus most on how to apply the ideas in the classroom.
Reciprocity	"Instructional coaches should expect to get as much as they give" (p. 50). Engaging in instructional coaching partnerships should allow the coach to learn along with the teachers, gaining insights into the teacher's practice, and the strengths and weaknesses of the ideas

being applied. In this space, instructional coaches must believe that the knowledge and expertise of the teacher are as valuable as their own, and have faith that the teacher will find new and useful ways to apply the ideas that were the focus of their partnership.

In an instructional coaching partnership, the coach and the teacher maintain these principles by engaging as equal partners, focusing on topics of the teacher's choice while encouraging the teacher to be open and honest about their opinions on content being learned (Knight, 2009). During coaching sessions the coach and the teacher engage in conversation around the content and reflect on, and consider how, to use different ideas within their specific classroom (Knight, 2007). A goal of instructional coaching settings is for the coach to learn alongside the teacher, learning about the strengths and weakness of different instructional strategies when implemented in different classrooms and gaining new perspectives on teaching strategies when seen and learned by the teacher (Knight, 2009).

Reflective practice between partners, as developed by York-Barr, Sommers, Ghere, and Montie (2006), draws many parallels with instructional coaching. This process involves "two or three people (dyads or triads) who collaboratively engage in a reflective learning process focused on improving educational practice" (p. 108). The ultimate goal is the enhancement of student learning opportunities and these conversations are built on the ideas of adult learning. Namely, that development should be "relevant to and embedded in practice, supported by collaboration among peers, and approached as a continuous and intentional process" (York-Barr et al., 2006, p. 120). When engaging in reflective practice, coaches need to be focused on creating constructive conversations that allow for the generation of ideas, problem solving, and examining of issues and events from different perspectives (York-Barr et al., 2006).

Coaching to support academic language knowledge and skills. As research on professional development around academic language is still in its infancy, there are few studies examine coaching models that explicitly support teacher development of science academic language knowledge and skills. Therefore, it is necessary to draw on studies that examine coaching as a means to support teachers who work with English language learners and broader conceptions of English language development. Teemant (2014) examined the effects of coaching for urban elementary teachers that focused on five research based practices: joint productive activity, language and literacy development, contextualization, challenging activities, and instructional conversation. The participating teachers engaged in a 30-hour workshop that focused on the five practices, followed by seven coaching sessions during the school year that involved a pre-observation meeting, observation, and post-observation meeting. This mixed methods study found that teachers showed statistically significant growth in the five practices, and that teachers valued the individualized support the coaching provided, the focus the coaching placed on student learning, and the changes that the coaching led to in their practice (Teemant, 2014).

Russell (2015) examined the ways in which a novice high school teacher learned to meet the instructional needs of English learners (ELs) through engaging with an instructional coach. This study focused on a first-year biology teacher who was coached by another teacher who served as both an ELL teacher and the EL facilitator for the school, preparing and facilitating teacher professional learning to meet the needs of ELs in mainstream classrooms. The author's analysis illuminated five key findings about the ways in which the teacher and coach interacted in this partnership to support the learning of EL students. First, the EL facilitator acted as a guide through the coaching cycle,

setting the focus and agenda for the meeting in order to address both the needs of the ELs as well as the needs of the teacher. Second, the EL facilitator served as a resource to the teacher, by providing a wide array of instructional strategies, practices, ideas and supports that could be used within the content classroom. Third, the observations that were completed by the EL facilitator allowed for the constant focus on the needs of individual ELs within the classroom by both the EL facilitator and the teacher, which in turn allowed for the EL facilitator to focus the teacher on the needs of specific students. Fourth, the engagement of the teacher with the EL facilitator in the coaching sessions mitigated the feelings of tension between needing to slow down to meet the needs of ELs and speed up to meet the needs of more proficient English speakers. Finally, the instructional coaching allowed for the teacher to connect with resources and practices from across the schools community, which Russell (2015) notes could possibly increase the consistency of opportunities for learning presented to the ELs.

Taken together, these studies highlight the potential benefits that instructional coaching can play in supporting teachers in developing their knowledge and abilities in supporting academic language development. Teemant's (2014) qualitative findings showed that teachers value the support that coaches provide and the ways in which those coaching partnerships can be used to focus on practice and knowledge development. Russell's (2015) findings complements above conclusions by showing how a coaching partnership can be leveraged to help teachers in providing instruction that supports the language learning of students. Buxton and Lee (2014) call for research that provides a "better understanding of how to support teachers in bringing together instructional strategies for rigorous academic content learning with English language development"

(p.219). This study sought to add to this understanding by examining the ways in which an elementary science teacher engages in an instructional coaching partnership focused on planning and implementing scaffolds for science academic language.

Using an Instructional Coaching Partnership to Support Teacher Use of Scaffolds for Science Academic Language

If students are to access the academic language necessary to engage in science content and practices, then it is important that they are supported in using and developing this language during their learning. For this to happen, teachers must identify ways to make the language their students need to be using transparent (Schleppegrell, 2004), and provide scaffolds to their students that help in their development (Dutro & Moran, 2003). With the increasing focus on academic language in schools (Ranney, 2012) it will be incumbent on professional development to support in-service teachers in growing their practices in supporting and scaffolding science academic language. Instructional coaching partnerships (Knight, 2007) provide one possible means for this professional development, and may provide the support that elementary science teachers need to identify, plan and implement scaffolds for science academic language. This study explores this possibility and examines how a teacher engages in planning and implementing scaffolds for science academic language while participating in an instructional coaching partnership. The following chapter describes the methodology of this study, including the research design, participant and context, methods of data collection, and the analytical process used to interpret the data.

Chapter 3: Methodology

The following chapter outlines this study's research design. After briefly restating the purpose of this research, the methodology is described, followed by detailed explanations of the participant selection, data sources and collection, and data analysis procedures. A discussion of how trustworthiness was established concludes the chapter.

Purpose

This study aimed to explore and understand:

1) The process of planning scaffolds for science academic language by an elementary science classroom teacher while participating in an instructional coaching partnership.
2) The ways in which planned scaffolds for science academic language are implemented.
3) The types of resources that assist an elementary science teacher in successfully planning scaffolds for science academic language.

Research Questions

To explore the experience of the classroom teacher, this qualitative research study aimed to answer the following questions related to the planning and implementation of science academic language instruction:

1) What actions and processes does an elementary science teacher engage in while planning instruction that scaffolds science academic language?
    a. What resources assisted the teacher in planning scaffolds for science academic language?

2) What actions and processes does an elementary science teacher engage in while implementing instruction that scaffolds science academic language?

Research Design

Classroom teaching experiment. This study employed a classroom teaching experiment methodology (Cobb, 2000). Classroom teaching experiments are a form of inquiry that occurs in collaboration with a classroom teacher with the focus of developing instructional activities for students that target a specific learning goal. As a result, classroom teaching experiments have been used to examine the learning of both teachers and students within a specific social context (Cobb, 2000). For example, Smit and van Eerde (2011) conducted two teaching experiments in collaboration with a classroom teacher to design lessons that would scaffold student language use during mathematics instruction, and through these teaching experiments, examined the learning that occurred for the teacher through her participation.

As a methodology, classroom teaching experiment has its roots in mathematics education and is guided by what Cobb (2000) calls the "emergent perspective" (p.309) on constructivism, which seeks a balance between the psychological/individual and social perspectives of constructivism, aiming to understand the learning of individuals as it occurs within specific social contexts. Classroom teaching experiments share characteristics of action research and design-based research, in that it is a form of developmental research that aims to produce both pragmatic and theoretical knowledge in partnership with practitioners through the use of an intervention. However, it differs from these approaches in two distinct ways. First, it differs from action research because the collaborating teacher is not involved in the research outside of what happens within the

classroom. Second, teaching experiments differ from design-based research in that the intervention is not analyzed and assessed beyond the analysis that is done within the classroom to inform the next aspect of the experiment (Yackel, Gravemeijer, & Sfard, 2015).

Teaching experiments allow researchers to experience first-hand, and investigate, the learning of both teachers and students, as it occurs within their specific and unique contexts. Within this methodology, instructional activities that target a specific learning goal are planned and developed by the research team; in the case of this study, the classroom teacher and researcher, which constitutes the "experiment." The "teaching" within this methodology constitutes the implementation of the instructional activities in the classroom by both the teacher and the researcher. Following this implementation, the instructional activities are analyzed to examine their effectiveness in supporting student learning of the targeted learning goal. In this case, the development and analysis of learning activities will focus on supporting students in using academic language during science instruction.

Classroom teaching experiments follow a recursive process. Instructional activities are developed, implemented and then analyzed by the classroom teacher and researcher for the purposes of refining them such that they better meet the targeted learning goals, as well as to inform future planning of instructional activities. Collectively, this iterative process comprises an entire "teaching experiment" and is modeled in Figure 3.1 (below). Following the completion of the teaching experiment in the classroom, the researcher completes a retrospective analysis of all the data collected throughout the teaching experiment to investigate the research questions guiding the

study. These data typically include video recordings of classroom activities, materials and records from planning meetings, student work artifacts, debriefing sessions between the researcher and teacher, and reflective journals (Cobb, 2000). The classroom teaching experiment methodology allows for the focus on both local reform as well as more generalizable information, which Cobb (2000) sees one of the strengths of the classroom teaching experiment methodology as it can enact "reflexivity between theory and practice" (p.314).

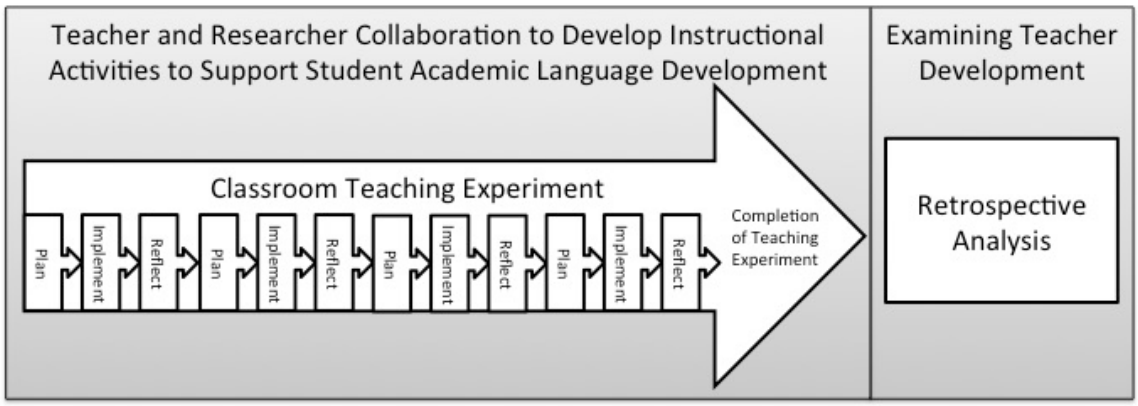


Figure 3.1. Model of classroom teaching experiment performed in this study.

The classroom teaching experiment in the present study (Figure 3.1) sought to provide instructional coaching to an elementary science teacher, Mr. Mills (pseudonym), to develop his abilities to scaffold science academic language use within his classroom. During this classroom teaching experiment, Mr. Mills and I engaged in a series of coaching conversations and classroom implementations in which we planned, implemented, and reflected on scaffolds for science academic language (Appendix A provides an example of the iterative process). The targeted learning goals of this study were to develop the teacher's abilities to scaffold science academic language, while

simultaneously building an understanding of the types of resources that assist elementary science teachers in providing academic language instruction within their lessons.

Context of the Study

Participant and selection criteria. This classroom teaching experiment was conducted in collaboration with a K-5 elementary science specialist at Walkerville Elementary School (pseudonym), located in a large Midwestern city. As this study aimed to understand the process of planning and implementing scaffolds for science academic language within elementary science lessons, the participant for this study was purposively selected. The participant in this study, Mr. Mills, was an elementary science specialist with whom I had previously worked on a different project. In this previous work, I supported Mr. Mills' growth as a curriculum developer and reflective practitioner, focusing on writing a STEM integrated curriculum and in developing his STEM pedagogy. During the time of the current study, Mr. Mills was in his sixth year of teaching elementary science, all of which occurred at Walkerville. He held a Masters of Arts in elementary education and was certified to teach K-6 elementary education and 5-8 middle school science.

This study aimed to understand how an elementary teacher planned and implemented scaffolds for science academic language, and it was therefore important for the participant to have extensive experience teaching science in the elementary grades. Therefore, Mr. Mills was an ideal participant for this study because of his position as an elementary science specialist. As an elementary science specialist, Mr. Mills taught science to students in kindergarten through 5th grade daily. Mr. Mills was also selected because of his commitment to providing his students with engaging, "hands-on and

minds-on" inquiry based lessons. In addition, during our previous work together, Mr. Mills had expressed a desire to support his students in learning science academic language and to scaffold their talking and writing around the science content they were learning in his class.

This classroom teaching experiment focused on one class of 5th grade students that came to Mr. Mills' science classroom, and selection of this classroom was done in collaboration with Mr. Mills. Mr. Mills was very interested in focusing our work on the selected 5th grade class as it was one of his school's "Language Academy" classes. Language Academy classes included a cluster of English Language Learner (ELL) students to allow for ELL services to be provided to students more easily within the classroom. He also felt this was one of his classes that would benefit the most from language instruction and support. Situating the research within this class allowed for a focus on not only verbal academic language development, but also writing and reading, as 5th grade students have more experience with writing and reading.

Over the course of this classroom teaching experiment, Mr. Mills and I engaged in coaching conversations spanning four units of instruction. These units were selected by Mr. Mills and were in part dictated by the district pacing guide. While Mr. Mills was not held to teaching specific units at specific points in the year, his district had identified the topics and units that were to be covered with 5th grade students, and provided a suggested outline of the order the units could be taught.

The first unit was an engineering design challenge in which students were required to design a mining tool for one of three resources: sand and gravel, iron ore, or trees. This unit was focused on students learning the engineering design process, as well

as science content around renewable and non-renewable resources. During this unit, Mr. Mills and I met for six coaching conversations in which we planned scaffolds to support student language use in a number of ways, including: drawing and labeling a diagram of their design, describing their design, explaining the steps for how to use their mining tool, justifying the changes they made during the redesign, and explaining why the client should choose to use their tool. Those instructional scaffolds were then implemented over the course of five class periods.

The second unit focused on students learning animal adaptations, exploring how animals have specific structures that serve a certain function to help them survive and reproduce. During this unit, Mr. Mills and I met for three coaching conversations where we planned scaffolds to support his students' talking and writing. These scaffolds supported the students in describing the adaptations found on specific animals, as well as justifying why a certain adaptation would be better than another. Mr. Mills implemented those scaffolds over the course of four class periods.

The third unit was different from the others in that it was a review of previously taught concepts in preparation for the upcoming state test. During this unit, students completed a series of individual lessons in which they engaged in activities centered on science concepts they had learned in previous grade levels. These science concepts included: heat transfer, designing an experiment, and levers. During this review unit, Mr. Mills and I held four coaching meetings to plan science academic language scaffolds. These scaffolds were meant to support his students in making predictions and recording observations during an experiment, describing which load and effort positions on a lever gave the greatest advantage, and explaining how they knew which ice cube melted the

fastest. These three review lessons, and the scaffolds we planned, were implemented over the course of four class periods.

The final unit was a design challenge in which the students were required to design a wind turbine blade. The learning in this unit was focused on students moving through a design process to design a wind turbine blade that would produce the most electricity. While planning for this unit, Mr. Mills and I engaged in seven coaching conversations to plan instructional scaffolds. During the unit, the students engaged in activities that required them to use language to make predictions and observations about a wind turbine, explain why they thought a wind turbine did not turn, share information from a reading, write a description of a possible blade design and why they chose that design, discuss with their group possible blade designs, and explain how they would redesign their blade and why they made those changes. These lesson activities and scaffolds were implemented over the course of six class periods.

Design of the Classroom Teaching Experiment

During this classroom teaching experiment — which took place between February 15, 2016, and June 8, 2016 — Mr. Mills and I collaborated in an instructional coaching partnership to plan and design instructional activities and scaffolds that were provided to his 5th grade Language Academy students during instruction. During this time Mr. Mills and I engaged in 20 coaching conversations that focused on the planning and designing of new instructional activities as well as the reflection on previous activities. The coaching conversations occurred during his prep time, and the instructional activities were then implemented that same afternoon. In total, the planned instructional activities and scaffolds were implemented over the course of 17 class periods. I attended all of these

class periods in order to support Mr. Mills in his implementation, and during this time acted as a participant observer, in which I was collecting data for the research project as well as serving as an additional teacher/teaching assistant within the classroom. Table 3.1 provides an overview of the coaching conversations, the language focus of each conversation, and lists the resources provided to Mr. Mills in each conversation.

Table 3.1

Design of Classroom Teaching Experiment Coaching Sessions

Unit	Date	Session	Overview of conversation	Language focus	Resources provided
Mining tool engineering	February 17, 2016	1	Initial conversation to begin the classroom teaching experiment. Focused first on discussing what would be happening in the coming class periods, then discussed the students in his class and which students to try to support and how. Then planned a support for student engineering diagrams.	Design materials realia (Kinard & Gainer, 2015) sheet created to support students in producing detailed engineering diagrams with labels.	No specific resources presented to Mr. Mills in this conversation.
	February 24, 2016	2	Focused on his students and how to support their academic language development to determine which students should be the focus of our work together. Discussed different possible lesson planning strategies as a means to support Mr. Mills in scaffolding academic language then I shared a couple of specific resources as well as possible directions we could take.	I shared some ways for thinking about language in lessons, including: sentence starters (Hill & Flynn, 2006), "brick" and "mortar" vocabulary (Dutro & Moran, 2003), linguistic enabling (Zwiers, 2014), anchor charts (Dorn & Soffos, 2005).	Provided Mr. Mills with the *Inquiry Prompts in Science* (Anoka-Hennepin School District, 2014) and Betsy Rupp Fulwiler (2007) sentence starters.
	March 7, 2016	3	Focused on mapping out the lessons that Mr. Mills would teach for the remainder of the year. Then created a student notebook pages for the mining tools engineering unit that students would use for evaluating their redesigned mining tools.	Planned sentence stems (Hill & Flynn, 2006) that the students would be presented to students for them to use while completing the notebook pages.	Shared an app with Mr. Mills that he could use to do digital science notebooks with his students.
	March `1bnm10, 2016	4	Focused on reflecting on the sentence stems that were provided to the students by examining the student work to see how the students did or did not use the scaffold. Created a student notebook page for a review of renewable and non-renewable resources and then evaluating the effectiveness of their mining tools on the alien planet.	Focused on discussing the types of responses that Mr. Mills would expect from his students as a starting point for developing targeted supports (Fillmore & Snow, 2002).	No specific resources provided to Mr. Mills during this conversation.

	March 14, 2016	5	Focused on developing a student notebook page for describing and communicating the students' final redesign and findings. We developed a sheet in which students were to describe the steps for how to use their tool as well as write a statement about why the mining company should choose their tool.	The language focus of this conversation was on Mr. Mills' expectations for describing the steps to use the tool and the procedural language his students would need to do write those steps.	No specific resources were provided to Mr. Mills during this conversation.
	March 16, 2016	6	Focused on finishing the final redesign sheet and creating promethean slides that Mr. Mills would present to his students to clearly share his expectations for the procedural writing. Clarified the types of responses that Mr. Mills was expecting from another prompt on the final redesign sheet and then planned scaffold.	Providing clear expectations for the procedural writing and including a sentence stem that students could use to support them in writing about why the mining company should choose their tool.	No specific resources were provided to Mr. Mills during this conversation.
Adaptations	March 21, 2016	7	Focused on planning the adaptations unit that was beginning that day and discussing the activities that students would be engaging in across the unit. Mr. Mills then shared some post-tests that he had given his 2nd grade students and described how well his students did, and how the language things that he did with this class really helped them in explaining the science they had learned.	Mr. Mills was focused in this conversation on the vocabulary terms that his students would need to learn, specifically around inherited and acquired traits, and structure and function. We also discussed if his students knew the general academic terms similarities and differences.	No specific resources were provided to Mr. Mills during this conversation.
	March 23, 2016	8	Focused on developing the instructional activities that Mr. Mills would do with his students to introduce the idea of adaptations and expand on the structure and function learning they had done in third grade. We developed promethean slides that he would use to introduce the topic to his students and explain the types of responses he was expecting around describing adaptations. We also revised the student notebook sheet they would be using during the activity.	This conversation led to planning some explicit language teaching (Schleppegrell, 2004) to help the students understand the types of responses they needed to provide when identifying and describing specific adaptations on animals. We then also developed some sentence stems that the students could use for the writing portion of the activity.	No specific resources were provided to Mr. Mills during this conversation

	March 28, 2016	9	Focused on discussing the bird beak activity that students would engage in and developing the slides that Mr. Mills would use to present this activity to the students. Mr. Mills was prepared for this conversation and had the student notebook page already developed when we started the conversation. We then discussed his expectations for the writing the students would do and he developed promethean slides to use with the students.	We discussed Mr. Mills' expectations for the writing his students would be doing around describing which beak worked best for which food source, and why. He shared the response he got from a student in another class and used that to develop a sentence starter to give to his students.	No specific resources were provided to Mr. Mills during this conversation
State Test Review	April 11, 2016	10	Focused on planning for what content needs to be covered over the next few classes to review for the state tests. Begins with overviewing the different science topics that need to be covered in the review and then we planned the activity his students would do to review experimental design and variables.	We discussed the content specific vocabulary terms that his students would need to understand while engaging in the experimental design and variables review. We identified terms that Mr. Mills would want to highlight during the activity.	We examined the test specifications for the state test to make sure that we were not covering unnecessary vocabulary terms that his students did not need to know for the test.
	April 13, 2016	11	Focused on preparing for an activity in which students would soak gummy bears in different liquids. Worked to develop the slide show a bit more to help his students understand the directions, and then developed the sheet his students would use when completing the experiment. Following this I then shared with him the Dutro and Moran (2003) framework as a way to think about the language students would be using in class. I briefly explained it to him and then shared it with him for him to read.	We focused mainly on the predictions that students would make after setting up their gummy bear experiment. We developed two sentence starters and listed them on the student workbook page above where they would be writing their predictions.	Explained the Dutro and Moran (2003) framework to Mr. Mills and gave it to him to read.

	April 20, 2016	12	Focused on discussing the Dutro and Moran (2003) framework after Mr. Mills had read it. Mr. Mills shared his thoughts around what was covered in the chapter as well as some of the different things he has struggled with when getting support in the past around scaffolding language in his classroom. Then spent a little time discussing the activities his students would be engaging in to review levers and moon phases.	Discussing Functions, Forms and Fluency from Dutro and Moran (2003) and Mr. Mills' perspectives on supporting language in his classroom. We also discussed some of the vocabulary that the students would be using to make sure Mr. Mills was clarifying what those terms meant.	Dutro and Moran (2003) framework and provided him with a Science and Children article that related to the work we were doing.
	April 27, 2016	13	Focused on preparing for the heat transfer activity that the students would be doing to review for the state test. We finished preparing his slideshow to provide clear directions for the students on what they would be doing, and then created a student notebook page that the students would use while completing the experiment.	In this conversation, we discussed Mr. Mills' expectations for student explanations of what they found in the experiment and developed sentence starters that the students would use while completing their explanations.	No specific resources were provided to Mr. Mills during this conversation.
Wind Turbines	May 4, 2016	14	Focused on planning ahead for the wind turbines unit. Laying out the plan for what will happen across the lessons and figuring out what materials will and will not work. Talked about lots of different possible ways the wind turbine unit could be done and making and making sure that Mr. Mills had what he needed in order to complete this unit.	Minimal focus on language during this coaching conversation. Some brief talk about predictions and other possible language functions that could be focused on during the wind turbines unit.	No specific resources were provided to Mr. Mills during this conversation
	May 9, 2016	15	Problem solving the wind turbine setup to make sure that it worked. We discussed the predictions his students would be making and Mr. Mills created some slides to support his students in knowing what a prediction is and how to make a prediction. Then Mr. Mills created a sheet for students to use while reading about renewable energy and wind turbines without my support while I worked with his materials to try to make his wind turbine work.	We focused on articulating what Mr. Mills expected for predictions from his students and then planned for instruction that would help his students understand this expectation. Mr. Mills then planned in some supports on his own for his students with a half sheet he created to be used with	No specific resources were provided to Mr. Mills during this conversation.

		The conversation closed with him explaining the worksheet to me and his expectations.	the reading they would be doing. Focused on them identifying facts and then sharing with a partner. Provided sentence starters on this sheet.	
May 11, 2016	16	Focused first on reflecting on the slides we created and the student use of half sheet during the reading activity. We then did some thinking ahead about next year and how he wants to create the routine/expectation in his room about how students should talk when they are in his room. We then planned for student designs of wind turbine blades and I supported him by creating a sheet for students to use based on directions that he gave me, while he attended to another matter.	He provided me guidance on creating a sheet for the students that we can use for their turbine designs and he identified that he wanted a sentence stem to support his students in justifying why they chose a specific design.	No specific resources were provided to Mr. Mills during this conversation.
May 16, 2016	17	Focused first on creating a student sheet to support their brainstorming of wind turbine blade designs. Then discussed how to scaffold students' sharing of their design ideas with their groups to support the group in coming to a single design idea.	We focused on how the students would share their ideas and the types of larger conversations we were hoping they would have around their designs. We planned a series of sentence starters that Mr. Mills would provide to the students help them in their conversations.	We used the constructive conversation skills poster (Zwiers, O'Hara, & Pritchard, 2014) to support our planning of the sentence stems.
May 18, 2016	18	Focused on reflecting on the students' use of the sentence starters and modeling that was done to support them in discussing their wind turbine blade designs. We watched video of the students and Mr. Mills shared what he noticed.	We discussed Mr. Mills' thoughts around what he saw the students doing and saying in the video, and how they were using the sentence starters for the conversations that we wanted them to have while discussing their designs.	Video recording of a group of students to see what they were doing/saying and how they were using the sentence starters.

May 23, 2016	19	Short conversation because the activities in the next lesson were just a work day and students were going to spend the class period constructing their wind turbine blades. Mr. Mills also shared with me how he was applying some of the things we had been talking about in our coaching conversations to other grade levels. We also discussed the future possibility of working together on digital science notebooks and seeing how students are talking and writing while using those.	Mr. Mills showed me how he was supporting his third grade students in describing the properties of rocks and minerals by providing them with a sentence starter and by coming up with a list of words they could use. He also found that students were using other words that they knew to describe the rocks and minerals as well.	No specific resources were provided to Mr. Mills during this conversation.
May 25, 2016	20	Focused on developing the final sheet that the students would complete around the wind turbine blades. This sheet was designed to support the students in describing their design and why they made it that way, analyze how their design worked, describe what they would change if they were going to make a new design.	We focused on developing sentence starters to scaffold student language use on the final wind turbine sheet. These sentence starters were planned for three sections of the sheet and were included directly on the sheet for the students.	No specific resources were provided to Mr. Mills during this conversation.

Data Sources

Data for this study were collected throughout the classroom teaching experiment. The primary data sources were audio recordings of the coaching conversations, video recordings of classroom instruction that followed those conversations, artifacts generated through the coaching conversations and classroom instruction, and the reflective journal that I kept during the classroom teaching experiment. An example of each data source is included in Appendices B-E. Table 3.2 provides an overview of the research questions along with the corresponding data sources and analytic processes used.

Table 3.2

Research Design: Questions, Data Sources, and Analysis

Research Question	Data Source(s)	Data Analysis
1. What actions and processes does an elementary science teacher engage in while planning instruction that scaffolds science academic language development?	1. Coaching conversations 2. Coaching conversation artifacts 3. Reflective journal	Retrospective analysis using constructivist grounded theory techniques (Charmaz, 2014; Cobb, 2000).
a. What resources assisted the teacher in planning scaffolds for science academic language?	1. Coaching conversations 2. Coaching conversation artifacts 3. Reflective journal	Retrospective analysis using constructivist grounded theory techniques (Charmaz, 2014; Cobb, 2000).
2. What actions and processes does an elementary science teacher engage in while implementing instruction that scaffolds science academic language development?	1. Video recordings of classroom instruction 2. Classroom instruction artifacts 3. Reflective journal	Retrospective analysis using constructivist grounded theory techniques (Charmaz, 2014; Cobb, 2000).

Coaching conversations. The main data sources used to examine Mr. Mills' actions and processes when planning instruction that scaffolds science academic language were audio recordings and transcripts of the coaching conversations. Over the course of the classroom teaching experiment, Mr. Mills and I engaged in 20 coaching conversations. All conversations were audio recorded and later transcribed verbatim.

During these conversations, we focused on discussing the activities his students were participating in, and then planned instructional scaffolds that would support his students in writing and talking about the science concepts they were engaging with in those activities. Additionally, these conversations included discussion of what academic language is, and Mr. Mills' perspectives about academic language and the role it plays in the classroom. These conversations were collected through the use of a digital audio recorder that was placed on the table. In facilitating these conversations I focused on maintaining Knight's (2007/2011b) partnership principles by providing Mr. Mills with *equality*, *voice*, *choice*, *dialogue*, and *praxis* in our conversations.

Classroom instruction. The main data source for exploring Mr. Mills' actions and processes when implementing scaffolds for science academic language was video recordings of Mr. Mills' classroom instruction. Over the course of the teaching experiment, the coaching conversations led to 17 lessons that included scaffolds for science academic language. Each of these lessons were 50-minutes long and were video recorded, using a video camera set up in the back of the room to capture Mr. Mills' instruction as well as the broader lesson activities. The video recording was started at the beginning of the class period and continued throughout the duration of the lesson. This was done to capture not only the specific language scaffolds that had been planned for through the coaching conversations, but also to capture any point-of-need scaffolding of language that occurred in Mr. Mills' instruction which was not planned for through the coaching conversations.

Coaching conversation and classroom instruction artifacts. To support the analysis of Mr. Mills' actions and processes while planning and implementing scaffolds

for science academic language, artifacts generated from the coaching conversations and Mr. Mills' classroom instruction were collected. The coaching conversations led to the creation of student notebook pages, interactive whiteboard slide shows, and graphic organizers that included language scaffolds. These artifacts were created using Google Docs and ActivInspire software, and were largely generated by Mr. Mills with support from myself. This collaboration helped in generating the worksheets and slideshows Mr. Mills would use in his classroom and is characteristic of classroom teaching experiments (Cobb, 2000) which allows the professional knowledge of teachers to be valued and used (H. Jung & Brady, 2016).

Reflective journal. Charmaz (2014) notes that journaling can be used to "engage in reflexivity and to avoid preconceiving your data" (p. 165) which allows a researcher to avoid bringing in their prior experiences and assumptions. This reflective journal served as a place in which I could be reflexive about the role I was playing within the study. It allowed me to acknowledge instances where I played a larger or smaller role in the planning or implementing of language instruction, or instances where I felt I influenced the direction of the conversations that Mr. Mills and I were having.

Data Analysis

Method for retrospective analysis. In classroom teaching experiments, two analyses are completed. The first occurs during the classroom teaching experiment in collaboration with the teacher to examine the progress toward the identified goal. This ongoing analysis serves to examine and modify the learning activities being provided to the students. Following the completion of the collaborative work with the classroom teacher, the researcher completes a retrospective analysis, which encompasses all the data

collected during the teaching experiment and aims to "place the classroom events in a broader theoretical context" (Cobb, 2000, p. 326). In this study, the ongoing analysis was done by Mr. Mills and myself to focus on the scaffolds he was providing to his students. Following our collaborative work together, I completed the retrospective analysis, which aimed to understand the actions and processes that Mr. Mills engaged in while planning and implementing those scaffolds. This retrospective analysis of the data was completed using constructivist grounded theory methods of initial and focused coding (Charmaz, 2014). This inductive approach allows patterns and trends to emerge from the data and creates theories or conceptual frameworks through these inductive analyses (Charmaz, 2006). Charmaz (2014) sees grounded theory as "a way to learn about the worlds we study and a method for developing theories to understand them" (p. 17). She notes that "we *construct* our grounded theories" (p. 17, emphasis in original) based on our involvement and interactions, past and present, with our research setting, participants and data. Grounded theory coding methods provided a useful structure for the retrospective analysis of data collected during this classroom teaching experiment as it allowed for an in-depth examination of the data through systematic analysis strategies.

Operationalized definitions of "actions" and "processes" in planning. To begin the analysis of research question 1, I first operationalized the terms "actions" and "processes" in relation to Mr. Mills' planning of scaffolds for science academic language. This was done to focus my initial coding to the aspects of Mr. Mills' planning that centered around language. "Actions" was defined as: What Mr. Mills planned through the coaching conversations. The analysis of actions was guided by questions such as: What does Mr. Mills plan for during the coaching conversations? What specific language or

aspects of language does he focus on with his scaffolds? What specific types of scaffolds does he plan to target the language his students are using in the lesson?

"Processes" was defined as: How Mr. Mills engaged in the coaching conversations. The analysis of processes was guided by questions such as: How did Mr. Mills engage in the planning of scaffolds for academic language? Are there instances when he is successful or struggles? What seems to lead to those successes or struggles? How does his engagement in the coaching conversations and planning of scaffolds change over the course of the teaching experiment?

Procedures for analyzing Mr. Mills' planning. The analysis of Mr. Mills' planning followed a number of specific analytic steps, the first of which was initial coding of the coaching conversations. Initial coding is the process of examining the data sources and actively naming the things seen in the data. This naming often involves the use of shorthand to define and label the data as a way to begin making sense of the data to guide the continued analysis (Charmaz, 2014). Charmaz (2014) advocates the coding of actions, the things that are happening, in the data as it reduces the tendency to code types of people, which can lead to focusing on "individuals rather than what is happening in the data" (p. 116). She notes that this initial coding needs to stay as close to the data as possible to remain open minded to any theoretical possibilities that may emerge.

The proofreading and editing of the coaching conversation transcripts served as a first pass, holistic review. During process of proofreading and editing the coaching conversation transcripts I kept a memo where I recorded specific aspects of the transcripts that I found interesting or illuminating. These coaching conversations were then inductively coded line-by-line through a process in which the coaching

conversations were listened to while reading along on the transcript. Lines and exchanges where language was the focus of the planning were coded using short phrases to describe what was occurring in that line. This initial coding lead to the development of 102 unique codes that were assigned to the data for a total of 536 coded instances across the 20 coaching conversations. As an example of the initial coding process, the following is a line from coaching conversation #15 (5/9/16):

> Mr. Mills: How about this? What happened? I saw… I observed… ((typing on Promethean slide))

This line was marked with three distinct codes. First, it was marked with the code, "Sentence Stem" to indicate the type of scaffold that was being planned. Second, it was marked with the code, "Mr. Mills generated scaffold" to indicate that Mr. Mills had generated this scaffold, and finally it was marked with the code, "Observations" to indicate the language function that the scaffold was developed to support.

Following the completion of the initial coding of the data, the initial codes were sorted by a top level code of either "Planning Actions" or "Planning Processes," based on whether the code described Mr. Mills' actions or processes in the planning that occurred during the coaching conversations. This was done to distinguish data extracts to allow further analysis of the actions and processes. Using the example above, of the three codes that were assigned to that line, the codes "Sentence Stem" and "Observations" were sorted into Planning Actions, while the code "Mr. Mills generated scaffold" was sorted into Planning Processes.

After sorting the initial codes by actions or processes, those codes were further sorted within those categories to develop focus codes. For example, the following codes:

"Posting sentence stems on board, Providing multiple options to students, Sentence stem, Sentence stem on worksheet, Sentence stems at tables for students" were all sorted under the focus code, "Sentence starters and frames." Table 3.3 shows the sorting of these specific initial codes. The full table of codes can be found in Appendix F.

Table 3.3

Sorting of Planning Codes to Move from Initial to Focused Codes

Top level code	Focus codes	Initial codes
Planning Actions	Sentence starters and frames	Posting sentence stems on board, Providing multiple options to students, Sentence stem, Sentence stem on worksheet, Sentence stems at tables for students.

Focused coding was then used to condense and sharpen the analysis. Focused coding is a process that is done by taking the most frequent or significant initial codes and applying them to "sift, sort, synthesize, and analyze large amounts of data" (Charmaz, 2014, p. 138). From the initial codes that were identified when coding the coaching conversations, 11 focus codes were developed, four focus codes for "Actions" and seven focus codes for "Processes." For Actions, the focus codes included: Sentence starters and frames, Other scaffolds, Vocabulary scaffolds, and Language functions. For Processes, the focus codes included: Discussion not leading to planned scaffolds, Discussing academic language, Generation of scaffolds, Improving practice, Language expectations, Language important to science, Reflection on scaffolds, Mr. Mills' perspectives. After the development of these focus codes, they were used to reexamine the coaching conversations to further analyze the actions and processes that Mr. Mills engaged in while planning to scaffold science academic language.

During the sorting process, an additional analytic process that I engaged in was memo writing. Memo writing is a technique in which the researcher stops and analyzes

their ideas about their codes; recording any and all ideas they have about their data to that point (Charmaz, 2014). It allows the researcher to stay involved in the analysis process and can help to increase the level of abstraction of ideas. As Charmaz (2014) says, "Memo-writing creates an interactive space for conversing with yourself about your data, codes, ideas, and hunches" (p. 162). Memos can be used immediately within the analysis process or can be stored and used later to draw together ideas across multiple memos. This process provides a space to "stop, focus, take your codes and data apart, compare them, and define links between them" (Charmaz, 2014, p. 164.) and allows for development of categories and themes. While developing the focus codes, I wrote memos in NVivo to note the ideas I was having, and the themes I was beginning to see emerge from the data around Mr. Mills actions and processes while planning to scaffold science academic language. An individual memo was written for both the actions, and the processes, of Mr. Mills' planning. These memos served as an intermediate step between coding the data and the development of the themes that were reported in the findings, and were added to throughout the final steps of the analysis process.

Following the development of focus codes, the data was further examined and themes were established. The following themes were identified for Mr. Mills' actions and processes while planning:

- Actions
    - Mr. Mills' planning of sentence starters to scaffold language use.
    - Mr. Mills' of planning other strategies to scaffold language use.
- Processes
    - Articulation of language expectations prior to planning specific scaffolds.

- Discussion of ideas that did not translate into actions.
- Reflection on student use of scaffolds.
- Discussing academic language in general.

These themes then served as the starting point for writing up the findings, which are described in Chapter 4.

Procedures for analyzing the resources that assisted Mr. Mills. The analysis of the resources that assisted Mr. Mills' in planning scaffolds for science academic language was completed following the analysis of Mr. Mills' actions and processes while planning. To begin the analysis of the resources that assisted Mr. Mills in planning, I first examined the codes that had been assigned during the analysis of his actions and processes, and identified codes that described a resource that was provided to Mr. Mills. These codes included both the providing of physical resources as well as coaching actions that served as a resource. For example, the codes, "Karl sharing resource" and "Karl asking for reflection" were identified as codes pertaining to resources that assisted Mr. Mills. Appendix G includes the codes that were identified as resources.

While completing the analysis and writing of the findings around Mr. Mills' planning and implementation, I also maintained an analytical memo in which I recorded thoughts, ideas, and themes that were emerging from the data. After identifying codes pertaining to resources that assisted Mr. Mills in planning scaffolds for science academic language, their corresponding data sources were examined. From this process, the theme, "Instructional coaching partnership assisted Mr. Mills' planning of scaffolds", was developed and this theme served as the starting point for the writing up the findings, which are described in Chapter 4. While writing up these findings I took the additional

analytical step of examining how Knight's (2007) partnership principles were utilized to assist Mr. Mills in his planning of scaffolds for science academic language.

Procedures for analyzing Mr. Mills' implementation. The analysis of Mr. Mills' implementation of scaffolds for science academic language followed a number of systematic analytical steps. The first step in analyzing the classroom instruction videos was to conduct what Cobb and Whitenack (1996) call an episode-by-episode initial analysis. This initial analysis involved watching each video of classroom instruction, and identifying specific episodes when Mr. Mills implemented scaffolds for science academic language. This provided a holistic view of the classroom implementation, and identified key episodes for further, more detailed analysis. As these episodes were identified, I created a table to document and organize these episodes, and included on that table the unit, the lesson number, a timestamp to indicate the section of video in which the episode occurred, and a memo recording a broad overview what was occurring in this episode. Table 3.4 provides an example of this episode by episode initial analysis for the first lesson of the mining tools unit. The full table is included in Appendix H.

Table 3.4

Example of Episode by Episode Analysis

Unit and Lesson	Timestamp	Overview of episode
Lesson 1 - Mining Tools – Part 1	9:00 – 15:00	Mr. Mills describing to the students how they should be explaining how their redesign did or did not work better. Provides students with a list of words that they could use to help them in writing their responses. Also makes a point of reminding them they are in 5th grade when sharing his expectations. Talks through students making a statement and proving it by referencing back to the pendulum activity they did earlier in the year. Connects it to Claim and Evidence.
Lesson 1 - Mining Tools – Part 1	15:00 – 17:30	I jump in and add possible sentence stems to support the students in writing their claim and evidence. Mr. Mills then adds at the end to remind the students that they use sentence starters all the time and that they don't have to start this way, but certainly can.
Lesson 1 - Mining Tools – Part 1	28:00 – 29:00	Mr. Mills passes out the paper and reminds students to use the sentence stems and to use 5th grade responses. Explains that he

		wants the students to work together, that it isn't an individual thing. All students writing, but talking about it together.
Lesson 1 - Mining Tools – Part 1	30:35 – 31:15	I shared with student that the sentence stems are on the board after he shares his idea with me.

The episode by episode initial analysis yielded 54 episodes from the classroom instruction videos that included implementation of scaffolds for science academic language. These episodes varied in length, ranging from 50 seconds to 8 minutes. After identifying these episodes, they were transcribed and imported into the qualitative data analysis tool, NVivo, for further analysis.

Following transcription, the identified episodes were subjected to initial and focused coding procedures similar to those used when examining Mr. Mills' planning. The initial coding used line by line coding procedures by reading the transcripts while viewing the classroom instruction video. This process of initial coding resulted in the generation of 289 individual codes that were assigned across the 54 key episodes. For example, the following is from Mr. Mills' implementation of the state test review on 4/13/16, and was coded as "Planned sentence starters on sheet":

> Mr. Mills: Now after this, even if you drop your gummy bear in there, nothing's gonna happen right away. These are gonna sit until Monday. I want you to make a prediction for each gummy bear. And I will tell you there's a sentence starter right there ((pointing to worksheet)) to help you get you started, okay? (Classroom Implementation, 4/13/16)

Following the initial coding of all the classroom instruction videos, the initial codes were again sorted into two major level codes, "Implementation Actions" and "Implementation Processes," and from there were sorted into groups to form focus codes.

The example above, was sorted into "Implementation Actions" as it described what Mr. Mills implemented, and was sorted into the focus code, "Implementation of planned scaffolds." Table 3.5 provides an example of this sorting process and the full table is included in Appendix I.

Table 3.5

Sorting of Implementation Codes to Move from Initial to Focused Codes

Top level code	Focus codes	Initial codes
Implementation Actions	Implementation of planned scaffolds	Planned sentence starter on board, Planned sentence starters on sheet, Planned vocabulary instruction, Planned word bank on board, Sentence starters to support conversation

In moving from initial to focus codes, the initial codes were condensed into seven focused codes, three focus codes for implementation actions and four focus codes for implementation processes. The focus codes developed for Mr. Mills' implementation actions included: Implementation of 'point of need' scaffolds, Implementation of planned scaffolds, and Language functions. The focus codes developed for Mr. Mills' implementation processes included: Implementation of scaffolds, Interaction with students, Making language expectations clear, and Teaching language. As with the analysis of Mr. Mills' planning, analytical memos were kept during the coding and sorting process to record thoughts, ideas, and themes that were emerging from the data through the analysis. In this case, these focus codes became the themes that served as the starting point for writing up the findings, which are described in Chapter 4.

Researcher's Background, Role, and Subjectivity

Researcher's role. As the aim of this study was to examine the development of a teacher in his ability to support academic language while participating in instructional coaching, I took a very prominent role within the classroom teaching experiment and the

data that were collected. Within constructivist teaching experiments, it is common for researchers to take on teacher, co-teacher, or instructional support roles as it allows for first-hand experiences with the learning and interactions in the classroom (Cobb, 2000; Steffe & Thompson, 2000). My role within this study was that of instructional coach. This role positioned me as a participant in both the planning and implementation of instructional activities to scaffold science academic language development, as well as in reflecting on the effectiveness of those activities in supporting students in talking and writing about science. My goal for this project was to support Mr. Mills through engaging with him in coaching conversations in which we discussed the language his students would be using and the ways in which we thought it could be scaffolded.

Throughout my graduate work at the University of Minnesota, I worked on a research project in a reflective practice and curriculum development partnership coaching role. In this coaching role, I supported individual teachers in reflecting on and refining their STEM pedagogy, as well as in developing STEM integrated curriculum. During this coaching partnership, I led reflective conversations with teachers, prompting them to reflect on and examine a specific aspect of their STEM teaching with the goal of identifying ways they could improve that aspect. As a part of this work, I participated in coursework to develop and grow my practices as a reflective partner and coach. This coursework included monthly meetings led by a senior graduate student over the course of two school years that included all the graduate students working as coaches on the project. In these meetings, we discussed specific strategies for engaging in coaching partnerships, engaged in practice coaching conversations, and reflected on the conversations we were having with the teachers we were coaching. These meetings were

facilitated by both graduate students with expertise in coaching, as well as by Dr. Jennifer York-Barr, a leading expert in the field of reflective practice and partnerships. As a part of this coursework we read two books focused on reflective practice and coaching, *Reflective Practice to Improve Schools: An Action Guide for Educators* (York-Barr et al., 2006) and *The Art of Coaching* (Aguilar, 2013).

In preparation for this study, I furthered my expertise in coaching by reading two works by Jim Knight, a leading author and researcher on instructional coaching. Specifically, I read his work around partnerships and instructional coaching, using his books *Instructional Coaching: A Partnership Approach to Improving Instruction* (Knight, 2009) and *Unmistakable Impact: A Partnership Approach for Dramatically Improving Instruction* (Knight, 2011) to further my learning. These texts served as a guide to shift the coaching work I had done previously from a reflective practice partnership to an instructional coaching partnership.

In the coaching conversations with Mr. Mills, I aimed to support him in reflecting on his activities and the language his students would need, while also be serving as an expert within this setting as my research interests are around academic language in science classrooms. Throughout my graduate work at the University of Minnesota I have studied the ways in which elementary teachers can scaffold student language use and learning within the science classroom, and have published (K. Jung & Brown, 2016) and presented numerous times on this topic at international conferences.

Balancing these roles is common within an instructional coaching partnership, and in these roles I focused on maintaining Knight's (2007) partnership principles of *equality*, *choice*, *voice*, *dialogue*, *reflection*, *praxis*, and *reciprocity* (refer to Chapter 2 for

detailed description). This was done to allow Mr. Mills to set the direction for our work together, and to allow him to generate scaffolds that he felt would work for him in his setting. To do so, when I did take on the role of expert, I presented possible scaffolds or resources he could use as options, and did not dictate how he should scaffold language within his classroom. The coaching conversation that was selected for inclusion in Appendix B to provide an example of the data collected highlights the partnership between Mr. Mills and myself, and our engagement in the partnership principles of *equality*, *voice*, *dialogue* and *praxis*.

My background and role during the data collection in this study are of note. At the time of data collection, I had taught for three years in an elementary school setting and was a doctoral candidate in a Ph.D. program. I had three years of experiences working on a grant project as a coach and reflective practice partner. I had also worked with pre-service teachers in both a mentorship/supervision capacity, as well as an instructional capacity. Most importantly, I had worked with Mr. Mills for two full school years and had developed a professional rapport and relationship with him.

Subjectivity is a part of every research project. However, as Peshkin (1988) notes, it is not enough to simply acknowledge our subjectivities. Researchers must observe themselves in focused ways to identify the qualities that may "filter, skew, shape, block, transform, construe, and misconstrue" (Peshkin, 1988, p. 17) their data. Throughout my completion of this study, I worked to examine and seek out my subjectivities to determine how they may have been influencing my data collection or analysis. I did this the by maintaining a reflective journal while working with Mr. Mills in the classroom teaching experiment and by writing analytical memos while completing the analysis.

Trustworthiness

Cobb (2000) notes that trustworthiness "is concerned with the reasonableness and justifiability of inferences and assertions" (p.328). In order to achieve trustworthiness when working with the data set gathered from a teaching experiment, Cobb (2000) advocates for a systematic and thorough analysis of the data that places early ideas and assertions under continual scrutiny and examination. Cobb and Whitenack (1996) present a method for analyzing large amounts of video recordings and transcripts collected from teaching experiments. They used a method that in many ways mirrored Glaser and Strauss's (1967) constant comparative method. Cobb and Whitenack's (1996) method focused on analyzing episode by episode, followed by a reanalysis of the claims and conjectures that came from the initial analysis. I followed this similar process to focus my analysis of the videos of Mr. Mills' implementation.

Regardless of the specific approach used, clearly documenting the analysis procedures, as well as the process of challenging, refuting and refining of initial conjectures is extremely important (Cobb, 2000). This allows for final claims to be justified by backtracking through the different levels of analysis and grounding the findings in the data. Charmaz (2014) suggests that studies using grounded theory methods be evaluated by examining their credibility, originality, resonance, and usefulness (p. 337-338), and provides a series of questions to support researchers in examining these four areas. Credibility is examined through questions such as, "Are the data sufficient to merit your claims? Has your research provided enough evidence for your claims to allow the reader to form and independent assessment – and agree with your claims?" (p. 337), while originality is addressed through questions such as, "Are

your categories fresh? Do they offer new insights? How does your grounded theory challenge, extend, or refine current ideas, concepts, and practices?" (p. 337). A studies resonance is investigated through questions such as, "Do the categories portray the fullness of the studied experience? Does your grounded theory make sense to your participants or people who share their circumstances?" (p. 338) and usefulness is interrogated through by asking questions such as, "Does your analysis offer interpretations that people can use in their everyday worlds? Can the analysis spark further research in other substantive areas?" (p. 338). She notes, "A combination of originality and credibility increases resonance, usefulness, and the subsequent value of the contribution" (Charmaz, 2014, p. 338).

The use of constructivist grounded theory methods for this study allowed for the type of systematic analysis that Cobb (2000) advocates. I accomplished this systematic analysis and the credibility for which Charmaz (2014) advocates, by using analytical memos to record early ideas, themes and assertions that were emerging as I progressed through the data analysis process. I also constantly returned to my data to further examine and explore the themes that were emerging, focusing on the originality of my work and how those themes challenged, extended and refined the work of others. As I completed my analysis, I maintained a memo in which I recorded my analytic steps and procedures, to maintain a transparent and clear process for how I arrived at the themes and conclusions, which served as the basis for the data analysis procedures detailed above.

The following chapter presents the findings of this study, examining the planning and implementation of scaffolds by Mr. Mills, and the resources that assisted Mr. Mills in that planning. The theoretical framework presented in Chapter 2 provides the grounding

for how Mr. Mills' actions and processes, and the role of the coaching partnership, were examined.

Chapter 4: Findings

This chapter presents the findings for this study and is divided into two sections, one for each of the research questions. The first section begins by presenting the themes that emerged through the analysis of Mr. Mills' planning of scaffolds for science academic language and is followed by the examination of the resources that assisted Mr. Mills while he engaged in that planning. The second section presents the themes that emerged through the analysis of Mr. Mills' implementation of the scaffolds for science academic language that were developed through the coaching partnership.

Research Question 1: What actions and processes does an elementary science teacher engage in while planning instruction that scaffolds science academic language?

a. **What resources assisted the teacher in planning scaffolds for science academic language?**

In this section I describe the findings from the analysis of Mr. Mills' engagement in the planning of scaffolds for science academic language. I first describe the language he planned to scaffold and the specific scaffolds he designed to support his students in using that language (i.e., Actions). I then describe how Mr. Mills engaged in the planning of those scaffolds while participating in the coaching conversations (i.e., Processes). Finally, I will describe the resources that assisted Mr. Mills in his planning of scaffolds for science academic language while he engaged in the coaching partnership.

Actions. In this study, I defined actions to denote *what* Mr. Mills planned for through the coaching conversations. This section will first provide an inventory and analysis of the scaffolds that Mr. Mills planned throughout the classroom teaching

experiment. Following this inventory, two themes that emerged about the scaffolds he planned and the aspects of language he chose to support with those scaffolds are discussed, and those themes are: 1) Planned scaffolds to support student understanding of how they were expected to structure their responses, and 2) Planned scaffolds to support student vocabulary use and development.

Inventory of scaffolds planned through the coaching conversations. Table 4.1 provides an overview of the scaffolds that Mr. Mills planned to implement through his engagement in the coaching conversations.

Table 4.1

Inventory of Scaffolds Planned Through the Coaching Conversations

Unit	Date	#	Planned scaffolds
Mining Tools	2/17/16	1	Realia word bank to support design diagrams.
	2/24/16	2	None
	3/7/16	3	Word bank to support mining tool writing.
	3/10/16	4	Began planning sentence starters for mining tool analysis.
	3/14/16	5	Continued planning sentence starters for mining tool analysis.
	3/16/16	6	Finished planning sentence starters for mining tool analysis.
Adaptations	3/21/16	7	None
	3/23/16	8	Planned instruction to clarify content specific vocabulary. Sentence starters to describe animal adaptations.
	3/28/16	9	Sentence starters for bird beak activity.
State Test Review	4/11/16	10	None
	4/13/16	11	Sentence starters to support predictions with gummy bears.
	4/18/16[1]		Sentence starters to support observations of gummy bears
	4/20/16	12	Sentence starter for explaining how levers work.
	4/27/16	13	Sentence starter for explaining which material had the least heat transfer.
Wind Turbines	5/4/16	14	Started developing sentence starters for introducing wind turbines. Predictions, observations, explanations.
	5/9/16	15	Finished developing sentence starters from previous coaching and developed sentence starters to support identification of facts from reading.

[1] On 4/18/16, I was running late and we did not hold a coaching conversation. Right before his preparation period ended, Mr. Mills quickly updated the worksheet he had generated the coaching conversation before, and generated two sentence starters for his students to use when making observations of the gummy bear experiment results. Because we were not engaged in a formal coaching conversation, this planning was not audio recorded.

	5/11/16	16	Sentence starter for justifying their turbine blade design.
	5/16/16	17	Sentence starters to support design conversations.
	5/18/16	18	None
	5/23/16	19	None
	5/25/16	20	Sentence starters for final wind turbine sheet.

Table 4.1 shows that Mr. Mills generated a number of "designed-in" (Sharpe, 2001) scaffolds through the coaching conversations, by planning specific scaffolds to support science academic language in 15 of the 20 coaching conversations. Of those coaching conversations, 13 led to sentence starters that were planned to be implemented with the students, while two of the coaching conversations led to the development of word banks to support vocabulary use, and one conversation led to the planning of targeted instruction to support students in learning content specific vocabulary. There were five coaching conversations that did not lead to the planning of scaffolds. Of these conversations, one was early in the classroom teaching experiment and was focused on establishing our routine and direction for our work, two occurred at the beginning of a unit and were focused on outlining what would occur during the unit, and two occurred on days when the students were constructing their turbine blades and there was no language use in the lessons to support.

Trends in Mr. Mills' planning of scaffolds. When examining the scaffolds that Mr. Mills planned for through the coaching conversations, Table 4.1 shows that the first two scaffolds Mr. Mills planned for were focused on supporting his students with the content specific vocabulary. This was unsurprising as science as a content area includes a high number of content specific vocabulary terms, and this is often what teachers focus on when supporting language during science lessons (Fisher & Frey, 2010). However, after coaching conversation #3 (3/7/16), and the associated implementation that occurred,

Mr. Mills' planning of scaffolds shifted to focus almost exclusively on planning sentence starters to scaffold student language use. As Table 4.1 shows, in 13 of the 20 coaching conversations Mr. Mills and I discussed and planned sentence starters that could be used with his students. Sentence starters are a strategy that can help students understand the structure and form of language while engaging in it through authentic contexts (Hill & Flynn, 2006). I introduced sentence starters to Mr. Mills as a strategy to scaffold student language use at the very end of coaching conversation #2 (2/24/16). In this conversation, I provided Mr. Mills with two lists of sentence starters that he could use as a resource to either pick a sentence starter from, or as a guide for developing his own sentence starters. Both resources were designed specifically for science, and included sentence starters for language functions that are common to science. These resources are included in Appendices J and K.

Mr. Mills' emphasis on planning for sentence starters was likely due to the concrete nature of the sentence starters, and the direct way that they influenced his students' language use. During coaching conversation #2 (2/24/16), Mr. Mills and I were discussing his needs and goals for our work together and Mr. Mills shared the following about what he felt he needed:

> Yeah, and what I need is, I need strategies that I can start writing about [in my lesson plans]. You know there's the whole class [responds], one row of students [responds], one student [responds] repetition stuff. There's the backwards build up, but those are the two that I know. You know, it's like give me, I want some more, you know, things that are good ways to [scaffold language]. (Coaching Conversation #2, 2/24/16)

From this quote, Mr. Mills felt he did not have strategies that he could plan to use to support his ELL students. He had also stated previously that he was looking for "practical stuff" (Coaching Conversation #1, 2/17/16) he could use with his students. The sentence starters filled this need for Mr. Mills, providing him with a strategy that he could tailor to each of his lessons, provide to his students, and he saw his students using the sentence starters and benefitting from them directly in his lessons. This was supported by his statements toward the end of the teaching experiment, when discussing some sentence starters that he had provided in the previous lesson and the valuable role he saw them playing in the classroom.

> I think it allowed the students, like we've been trying to have them do, some sought of guidance. And I think, this is just my own personal thing, I think that for the English language learners, seeing the [native] English language speakers be forced to do the same thing as what they have to do, I think that matters…I think that for confidence, like it's the difference of, so you speak great English just give me the answer. Oh but you, you are learning English, so why don't you follow these sentence [starters] for me. (Coaching Conversation #16, 5/11/16)

Mr. Mills felt that by providing the sentence starters, and requiring that all of his students use them, he was building confidence in his ELL students and that they would not feel singled out by having to use a scaffold that the rest of the class did not have to use.

Mr. Mills planned scaffolds to support student understanding of how they were expected to structure their responses. The first theme that emerged when examining the types of scaffolds that Mr. Mills planned during the coaching conversations was that he primarily planned scaffolds that would support his students in understanding how they

were expected to structure their responses to specific questions or prompts. He planned to scaffold his students understanding of his expectations for their responses by providing his students with the sentence starters. As discussed above, in 13 of the 20 coaching conversations Mr. Mills and I discussed and planned sentence starters that could be used with his students.

When planning the sentence starters during our coaching conversations, Mr. Mills identified two specific ways that he would provide his students with the planned sentence starters. The first way that Mr. Mills planned to provide the sentence starters to his students was by posting them on the Promethean® board, the interactive whiteboard in his room, for students to reference as they worked. He did this by typing the sentence starters onto the slides in his Promethean slideshow that he used to guide his students through each lesson. He then planned to post those sentence starters, explain them to his students, and leave them up for students to reference as they wrote or talked, so that his students would have a clear example of the types of responses that Mr. Mills was expecting.

For example, during coaching conversation #9 (3/28/16), which occurred during the adaptations unit, Mr. Mills planned a lesson in which the students were engaged in a bird beak activity to explore how specific adaptations would allow a bird to gather more food. In this activity, the students were provided with a number of "bird beaks" simulated by a spoon, a skewer, a pair of tweezers, and a drinking straw. The students also had four different food sources simulated by water, large marbles, Swedish Fish candy, and small marshmallows. The students then tested different beaks with different food sources. Following the activity, the students wrote explanations to describe which beak worked the best for a food source. In planning for this activity, Mr. Mills wrote two sentence

starters that he had planned to provide to the students in his Promethean slideshow (Figure 4.1).

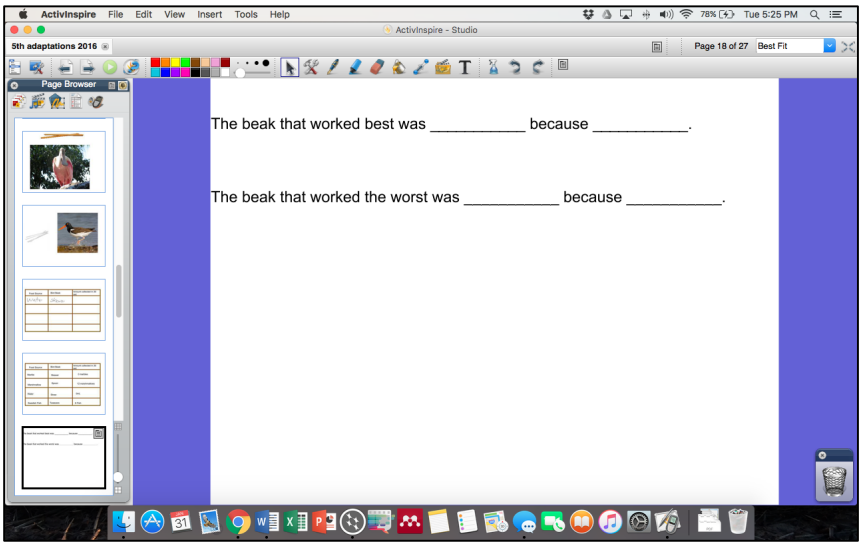


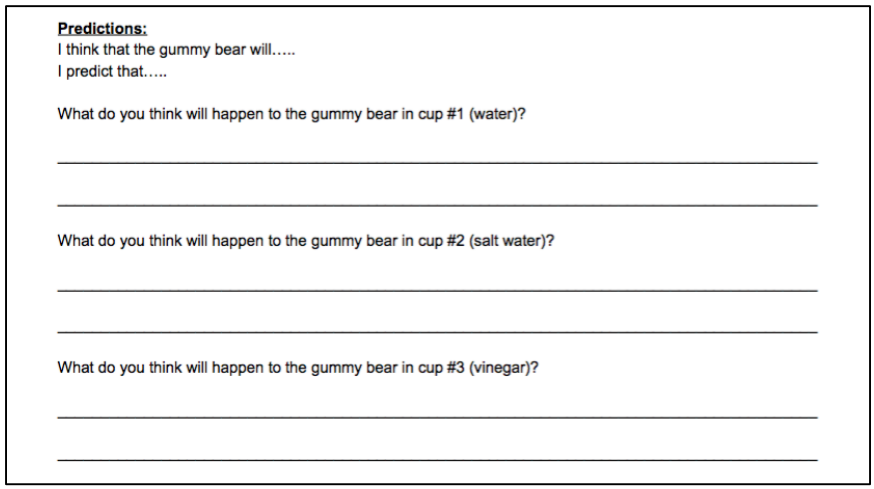
Figure 4.1. Sentence starters provided during bird beak activity to support student responses.

Mr. Mills wrote these sentence starters into his Promethean slideshow and planned to post them on the board for his students to use while analyzing the data the collected during the bird beak activity. He planned these to support his students in the writing the students were doing in response to two prompts on their worksheet: "Which bird beak worked the best? Why?" and "Which bird beak worked the worst? Why?"

The second way that Mr. Mills planned to provide his students with sentence starters to scaffold their language use was to include those sentence starters directly on the student worksheets that they completed during the lessons. This was done so that the scaffold was directly in front of the students when they were working and they did not have to reference the Promethean board. Mr. Mills did this by typing the sentence starter directly onto the student worksheets that he was creating, and were either listed above the

space where students could write their response, or were included directly in the space where the students were expected to write their response.

One example of this inclusion of sentence starters on the student worksheets comes from coaching conversation #11 (4/13/16), which occurred during the state testing review unit, and covered the topics including: how to set up a scientific experiment, heat transfer, and levers. During this conversation, Mr. Mills was planning for a lesson that was intended to review with the students how to set up an experiment. In this lesson, the students were all running an experiment in which they soaked gummy bears in different liquids and observed what happened to the gummy bears. Prior to setting up the experiment Mr. Mills reviewed with the students what variables were, and led a discussion about which variables they wanted to change and which ones they wanted to keep the same. Once the students had set up their experiment and had a gummy bear soaking in three different liquids, they made a prediction for each liquid. In developing the worksheet that the students would use to track their experiment, Mr. Mills included two sentence starters for the students to use (Figure 4.2).


Predictions:
I think that the gummy bear will.....
I predict that.....

What do you think will happen to the gummy bear in cup #1 (water)?

What do you think will happen to the gummy bear in cup #2 (salt water)?

What do you think will happen to the gummy bear in cup #3 (vinegar)?

Figure 4.2. Prediction sentence starters included on the student worksheet to scaffold responses.

These sentence starters were developed to support the students in making their predictions about what would happen to the gummy bears during the experiment. Mr. Mills provided these sentence starters to make clear to his students how he was expecting them to write their predictions and structure their responses.

Throughout the teaching experiment, Mr. Mills provided his students with sentence starters to scaffold their responses on both the Promethean slides and on their worksheets. When Mr. Mills initially planned sentence starters to scaffold his students' responses, he planned to only post them on the board for his students to use. These particular sentence starters were planned during coaching conversations #6 (3/16/16), #8 (3/23/16), and #9 (3/28/16). Each of these sets of sentence starters were planned to be used by the students to write responses on their student worksheets. After this point, when Mr. Mills planned sentence starters to scaffold his student responses, if the students were going to be using the sentence starters to scaffold their writing Mr. Mills included them directly onto the student worksheets. This allowed Mr. Mills' students to have the sentence starters directly in from of them when writing their responses. Mr. Mills also continued to plan sentence starters into his Promethean slideshows to post for the students, however these sentence starters were instead planned to be used to support the students' verbal responses while the class was gathered at the carpet for instruction.

Mr. Mills planned scaffolds to support student vocabulary use and development.

The second theme that emerged when examining the types of scaffolds that Mr. Mills planned during the coaching conversations was that he created scaffolds to support his students in their vocabulary use and development. In contrast to the frequent planning of sentence starters to support his students in understanding the types of responses they were

expected to provide, Mr. Mills planned only three scaffolds to support his students in their vocabulary use and development.

As noted in Table 4.1, the first two scaffolds that Mr. Mills planned through the coaching conversations were scaffolds for the content specific vocabulary that his students would need during the lessons. He did this by creating word banks for his students to use. For example, in coaching conversation #1 (2/17/16), Mr. Mills was preparing for a lesson in which his students would be designing their mining tools. In this lesson, the students were to work as a team to create a design of their mining tool, and record this design on their worksheet with a labeled diagram and a materials list. As Mr. Mills and I were discussing these labeled diagrams, Mr. Mills shared that his students would get the words for each material off the Promethean board, from a word bank that he had created. He then noted that he wanted to be sure his students knew what each of the materials were and said, "But what I would do is, I don't have time to do it. [I would] get a piece of paper and put one of each item glued on the paper and label [each item]" (Coaching Conversation #1, 2/17/16). After additional conversation, Mr. Mills and I decided we did have time to make these, and created two of these sheets to provide to the students (Figure 4.3).

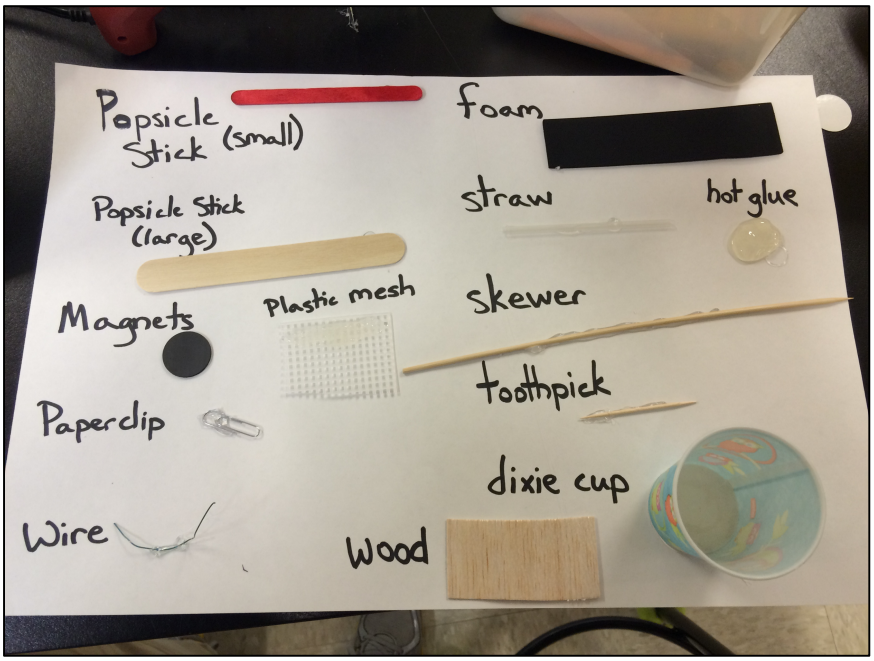


Figure 4.3. Realia word bank to scaffold students' labeled diagrams of their mining tools.

These realia word banks were created to scaffold the students in creating their labeled diagrams by providing the students with the items they could use in their designs, with the name of that item directly with the item. Mr. Mills' goal was to make sure that the students clearly knew what, for example, a skewer was and could label it clearly in their designs. Mr. Mills planned to place the two word banks that we created on the tables where the students were working with their groups so that students could access the vocabulary necessary to make their labeled diagrams. He also took a picture of one of the sheets and posted it on the Promethean board so the students had another place to reference the word bank.

The third scaffold that Mr. Mills planned to support his students in their vocabulary use and development occurred during coaching conversation #8 (3/23/16). In this conversation, Mr. Mills was planning for a lesson in which the students would investigate specific animal adaptations, and how that adaptation helped the animal

survive. During this planning, Mr. Mills planned to review animal structures and functions, which he had covered with the students in 3rd grade, before moving into defining them as adaptations. In doing this, Mr. Mills planned to clarify with his students what "structures" and "functions" are, and created the following Promethean slide to use during his instruction (Figure 4.4).

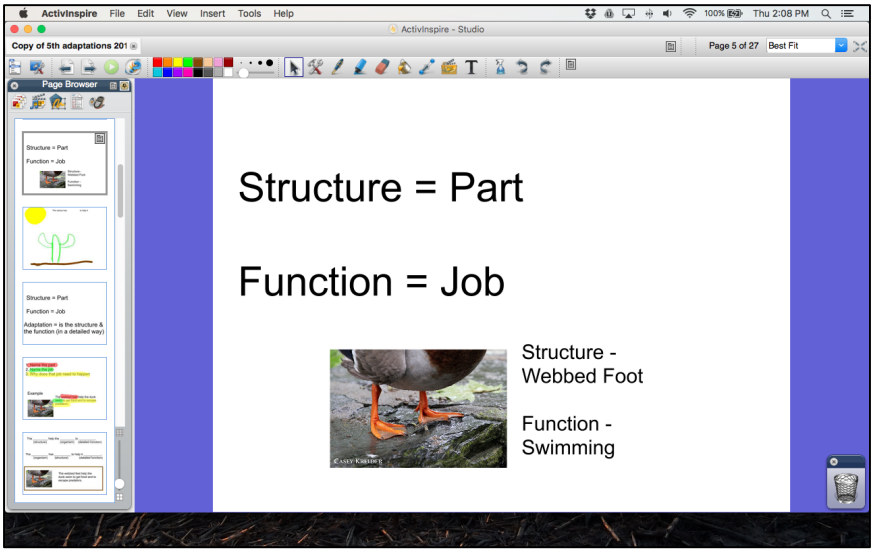


Figure 4.4. Promethean slide created to clarify the meaning of "structures" and "functions."

By creating this slide, Mr. Mills planned to use the common, everyday terms of "part" and "job" to clarify for his students what "structure" and "function" meant. The terms part and job were terms that his students were likely to be more familiar with, and would help reinforce their understanding of the science concepts.

These scaffolds to support the students in their vocabulary use and development were aimed at making sure the students had the vocabulary that they needed to complete a writing task, or understand the science concept with which they were engaging. Mr. Mills planned these three scaffolds in the first half of our work together in the teaching experiment. After coaching conversation #9 however, his planning shifted to the

identification of sentence starters to support his students in understanding the types of responses that he was expecting. Two factors played into this shift from vocabulary scaffolds to scaffolds for the structure of student responses. One, as the coach, I made a conscious effort during our coaching conversations to ask about language that was not just vocabulary as that is frequently what science teachers will focus on (Fisher & Frey, 2010), and vocabulary is only one piece of the academic language students need to learn (Ranney, 2012). The second factor that played into this shift was Mr. Mills' goals for the students in his classroom. During coaching conversation #12 (4/20/16), when discussing science academic language and his students, Mr. Mills described one of his goals for his students, "…you know I just want them to tell me what they did to begin with." Mr. Mills was concerned about supporting his students in the writing and talk they were doing around the activities and investigations they were engaging in during his lessons, and therefore was less focused on the specific vocabulary terms they would be using.

Processes. The following section describes the findings in relation to processes that Mr. Mills' engaged in while planning to scaffold science academic language. In this study, I have defined "processes" to denote *how* and *why* Mr. Mills planned specific scaffolds through the coaching conversations. Through the analysis of his processes, three themes emerged: articulating language expectations, discussion of ideas that did not lead to planned scaffolds, and reflection on academic language and scaffolds. Each of these themes are described in detail below.

Articulating language expectations before planning specific scaffolds. One of the themes that emerged through the analysis of the processes that Mr. Mills engaged in while planning to scaffold science academic language was a need to clearly articulate his

expectations for students' language use before he would identify scaffolds necessary for his students. It is important for teachers to have clear understandings of their expectations for student language use (Schleppegrell, 2012), and by articulating those expectations teachers are better prepared to scaffold their students in using that language (Dutro & Moran, 2003). During the classroom teaching experiment, this process of articulating the language expectations by Mr. Mills occurred across 18 of the 20 coaching conversations, at times happening in multiple instances throughout a single coaching conversation as Mr. Mills worked through planning scaffolds for the language his students would use. In many of these instances, this articulation followed a similar pattern in which Mr. Mills would first share a classroom activity that the students would be engaging in that would require them to use language, followed by me asking Mr. Mills what his expectations were for his students when using that language. Extract 1 demonstrates such an exchange.

Extract 1 – Coaching Conversation #1 – 2/17/16

89	Karl	So then with that writing, are you expecting sort of like a complete sentence?
90		Like what would you want to see?
91	Mr. Mills	For the procedural? Um…
92	Karl	Like what would you expect?
93	Mr. Mills	Honestly, I was thinking like a numbered list.
94	Karl	Like a numbered list.
95	Mr. Mills	Yes
96	Karl	Okay like one, two. Okay that works too but so then like those statements?
97		What?
98	Mr. Mills	Yeah because I think for me what I have always gone for with that kind of
99		thing is, could you give it to somebody else and have them build it, is it that
100		clear.

In this extract, Mr. Mills and I were engaging in the first coaching conversation of the teaching experiment. During this conversation, Mr. Mills and I were discussing the mining tools that the students would be designing in the upcoming lesson. As a part of the process of designing the mining tool, Mr. Mills was planning for his students to do some procedural writing to describe how to build their mining tool. After sharing that the

students would be doing procedural writing, I asked what his expectations were for that writing and what he would want to see in a student response (line 1) and if he was wanting students to use sequencing words such as "first, next, last" to complete this writing (line 3). Mr. Mills shared that he was thinking the students could do a numbered list, where they would use numbers to sequence the steps (line 4). He then goes on to share that his goal was for the students to include enough detail in their writing that they could "give it to somebody else and have them build it, [was] it that clear" (line 8). This discussion ultimately led to Mr. Mills deciding to focus on the drawing of the mining tool design and the planning of the realia word bank discussed above.

There was one instance during the coaching conversations that the discussion of language expectations resulted in Mr. Mills clarifying the prompt that he was going to provide to his students. During coaching conversation #6 (3/16/16), Mr. Mills and I were discussing the final design analysis the students would be doing after testing their mining tool on the alien planet. As we were talking through the writing that Mr. Mills wanted his students to do, he realized that one of the prompts he was planning to provide the students was not asking the correct question, and would not get the type of response that he wanted (Extract 2, key lines are in bold).

Extract 2 – Coaching Conversation #6 – 3/16/16 (key lines are in bold)

80	Mr. Mills	But for this one, resource because it, **how do I describe what I want there?**
81	Karl	**Say again what you were thinking [students will be saying]?**
82	Mr. Mills	So you'd like make like a statement about, like it's almost a claim.
83	Karl	Yeah I know, just say it again, what you were sort of thinking so that I can
84		[understand what you are hoping they will say].
85	Mr. Mills	**This tool will get iron ore because it can remove it from the ground, separate**
86		**it from the sand and gravel, and get it in the container. ((pause)) Oh no, that's**
87		**not what I want.**
88	Karl	That's not what you want?
89	Mr. Mills	No. This tool will get iron ore because the design, or how it's built…this tool will
90		get iron ore because we designed it that way.

91	Karl	Yeah I don't know what you would call that, what you would put underneath it to
92		help guide them. I also don't know exactly what they would say.
93	Mr. Mills	Maybe we should just see what they say?
94	Karl	Yeah I'm wondering if they're going [to] be confused about how that is different
95		than the steps.
96	Mr. Mills	**Like this tool will get iron ore because it works. I think is what we're going to**
97		**get. And I don't want that.** So maybe we should get rid of that?
98	Karl	**Or change it, like come up with a slightly different prompt.**
99	Mr. Mills	Like change that? ((writing in Promethean slides))
100	Karl	**Yeah like change this prompt.**
101	Mr. Mills	Tell me why your tool is awesome? Seriously!
102	Karl	It's awesome because we made it? Like what are you wanting for that? Or is that
103		good?
104	Mr. Mills	**Tell me why your tool, tell me why I should bring your tool to another planet**
105		**to use? Why is your tool, why would I choose your tool your tool to mine on**
106		**another planet?**
107	Karl	**Okay and then something that they could say [would be], "because it worked**
108		**well for getting out the iron ore."**
109	Mr. Mills	Exactly
⋮		
134	Mr. Mills	**((typing on Promethean slides)) Why would I choose to bring your tool to [the**
135		**alien planet]? I'm thinking of the sentence, you should choose my tool, our**
136		**tool because…**

Mr. Mills' realization that the prompt needed changing came while attempting to describe the responses he was expecting from his students, "This tool will get iron ore because it can remove it from the ground, separate it from the sand and gravel, and get it in the container. ((pause)) Oh no, that's not what I want" (Lines 85-87). As the conversation continued, Mr. Mills continued to try to articulate the types of responses he wanted from his students, which ultimately led the suggestion by me to change the prompt (Lines 98-100). Mr. Mills then adjusted the prompt so that it asked his students for the type of response that he was looking for, and after making this clarification, Mr. Mills quickly identified a sentence starter, which he planned to place on the Promethean board, that he would provide to his students to scaffold their language use during this activity (Lines 134-136).

As we progressed through the teaching experiment, our conversations around articulating the language expectations began to shift. Mr. Mills became more apt at identifying his expectations for how he wanted his students to use language, and focused his conversation much more on identifying the scaffolds he wanted to provide his students. In early conversations during the teaching experiment, such as Extract 2 (3/16/16) discussed above, Mr. Mills needed to spend more time talking through the types of responses he was hoping for from his students prior to identifying the scaffolds that he wanted to provide his students to support their language use. In contrast, during conversations that occurred later in the teaching experiment, Mr. Mills spent less time discussing and articulating exactly what he wanted his students to say or write, and instead jumped straight into writing sentence starters that he would provide to his students to scaffold their talk and writing during the lessons.

An example of this shift comes from coaching conversation #16 (5/11/16), which occurred during the wind turbines unit. In this conversation, Mr. Mills and I were discussing the designs that the students would be creating of their wind turbine blades. In the middle of this conversation, Mr. Mills needed to meet with a student teacher who was preparing to teach a lesson in his room. In order to support Mr. Mills, I offered to create the design sheet the students would use while designing their blades, while he met with the student teacher. In doing so, I asked Mr. Mills to provide me with an outline of what he wanted on the sheet for his students so that I was sure to include everything they needed (Extract 3).

Extract 3 – Coaching Conversation #16 – 5/11/16

285	Mr. Mills	Typical name and date stuff at the top…[then] height, width and then, alright so I
286		want to put, because we've been working on it, you know "we chose this design
287		because"
288	Karl	Okay. So you want them to like
289	Mr. Mills	I want them to justify, I want to know why
290	Karl	Why did they think this will be a good design?
291	Mr. Mills	We chose this design because. So if I walked over to them I would say, "why did you
292		make your turbine blade this shape?" [And students would respond] "We chose this
293		design because it is really wide and it will catch the [wind].

Whereas in earlier coaching conversations it took Mr. Mills a little time to work through articulating his expectations for language use, in describing to me what he wanted the design sheet to include, Mr. Mills very quickly and directly stated his expectations for language use. Mr. Mills provided this direct statement of his language expectations by identifying a sentence starter to provide to students, "we chose this design because" (Lines 286-287). He then continued, stating, "I want them to justify I want to know why" (Line 289) and then explained that he wanted to be able to go over to students and ask them why they made their turbine the shape they did and have them tell him something like, "we chose this design because it is really wide and it will catch the [wind]" (Lines 292-293). In this coaching conversation, Mr. Mills had a very clear idea of the language he wanted his students to use in the lesson and was able to articulate it very quickly, while identifying a sentence starter that could be provided to his students to scaffold their justifications.

Discussion of ideas that did not translate into actions. The second theme that emerged through the analysis of Mr. Mills' processes while planning to scaffold science academic language was the discussion of possible scaffolds that did not translate into actions. Across the classroom teaching experiment, Mr. Mills and I discussed strategies that could be used to support Mr. Mills in identifying scaffolds for science academic

language, or strategies that could be used with the students to scaffold their language use. However, at times these conversations did not actually lead to planned scaffolds or follow through on the strategies that were discussed. Specifically, the strategies and scaffolds that did not translate into actions were: including language modifications on lesson plans to provide to a teaching assistant and differentiating scaffolds for different students.

Including language modifications on lesson plans to provide to a teaching assistant. During the second coaching conversation (2/24/16), which occurred during the mining tools engineering unit, Mr. Mills and I started by discussing the students in his class. He shared that he was struggling with how to help them understand how to design a mining tool. Mr. Mills felt his students lacked background knowledge of mining tools and was feeling unsure about how much information to give his students so that they could come up with a design, without stifling their creativity in those designs. During this conversation, he shared how it was challenging for him to explain what he wanted to his Karen-speaking ELL students who had the least English language proficiency. To support these students with the lowest levels of English, Mr. Mills' school was already providing a teaching assistant, Amy (pseudonym), who spoke Karen. Amy came into Mr. Mills' classroom for approximately the final 25 minutes of each class period and worked directly with the group of students with the lowest English language abilities.

As Mr. Mills and I were discussing his students during this coaching conversation, I provided the suggestion that perhaps we could continue to leverage this teaching assistant by preparing a written summary of what the students were expected to be doing each day, so she was better prepared to support the students by using their home language resources (Buxton & Lee, 2014) (Extract 4).

Extract 4 – Coaching Conversation #2 – 2/24/16

85	Karl	[We can] continue to use and leverage Amy, and maybe one of the things to do is, we
86		could try to have prepared better instructions to give to her.
87	Mr. Mills	Sure yeah.
88	Karl	So that she not coming in [while] you're in the middle of [working with other
89		students] [and then] trying to explain it in the moment [what the students are doing].
90		Instead maybe [you can] have something [written that says] here's what we're doing
91		today.
92	Mr. Mills	You know what we should do, because, I know what I need, I need to design, a one
93		page [lesson plan template]. Because right now I use this program to lesson plan, it's
94		[called] Planbook. But it's not, it's customizable as far as schedule, but it actually is
95		too complicated.
96	Karl	Okay
⋮		
102	Mr. Mills	The problem is, I just want to make a one page lesson planning template that includes
103		a field for ELL modifications and what those modifications would be, [so] that once
104		it's planned, I could cut and paste it onto a separate sheet for somebody like Amy and
105		say this is what you are doing today.
106	Karl	Sure
107	Mr. Mills	Because I can't do that with [Planbook]. I want it to be like a spreadsheet.
108	Karl	An excel sheet.
109	Mr. Mills	[An] excel sheet, that I could just make a master of and then just have one for [each
110		day].
111	Karl	Yeah
112	Mr. Mills	But I want basically what are they learning, how are they going to learn it, how do you
113		know [they have learned it]. Like those kind of things and then okay great, here's the
114		ELL section.

This suggestion was provided because each day when the teaching assistant came in the room, Mr. Mills would quickly try to explain what was going on in the class and then the teaching assistant would sit down with the group and support them as needed. Mr. Mills built off this suggestion and stated that what he thought he needed was to have a lesson planning format that included a section dedicated specifically to "ELL modifications and what those modifications would be" (Line 10), with the goal being that he could copy those modifications onto another document to provide to someone such as Amy. We discussed a few possible ways he could create this template, possibly through a spreadsheet or Google doc, or the possibility of him using a lesson planning program he used called, Planbook. As this conversation progressed, and we continued discussing

possible ways he could develop this lesson planning template, Mr. Mills decided that he would work the modifications into his existing lesson planning using the Planbook application.

Ultimately, however, this type of lesson planning to provide information to the teaching assistant did not occur during the teaching experiment. This type of planning would have required Mr. Mills and I to be focusing our conversations on language tasks in future lessons to allow time for Mr. Mills to develop the information for the teaching assistant. Instead, the planning that occurred through our coaching conversations was always focused on developing scaffolds for the lesson that the students were being taught that very afternoon. Because of this, when thinking about how to scaffold his students' language use the planning was always focused on scaffolds that would be immediately used and developing the slideshows or student worksheets that would be used to provide those scaffolds. This approach did not allow for the type of lesson planning that Mr. Mills discussed or the generation of specific information that could be provided to the teaching assistant to support the ELL students.

Differentiating scaffolds for students. The second strategy discussed that was not translated into action was providing differentiated scaffolds for specific students within Mr. Mills' classroom. Early in the teaching experiment, Mr. Mills mentioned that he was, "…fine giving the language academy kids' one thing and the other kids something else" (Coaching Conversation #1, 2/17/16), and that he thought we could provide his ELL students one set of scaffolds and use a different set with his native English speakers and ELL students with higher English proficiency. However, in the planning that resulted throughout the teaching experiment this was not the case. All students were provided the

same worksheets and the various scaffolds that Mr. Mills planned were provided to all students in the same way across the entire teaching experiment. There were two factors that likely led to Mr. Mills not differentiating the scaffolds he provided to his students. The first factor was that Mr. Mills felt his students, in general, needed a high level of support, and so he tended toward providing all students the same scaffolds. During the last coaching conversation (Coaching Conversation #20), I suggested to Mr. Mills that perhaps we could differentiate the sentence starters that he was planning to provide to his students, and give some specific students in his class a scaffold that either provided more support or less support. He pushed back against this suggestion by saying, "…I know that we're trying to get them to move on and do it on their own but I just don't know if they're there yet." Mr. Mills felt, even at the end of the teaching experiment, that he needed to provide all his students the same sentence starters so they would have the support they needed when completing the writing in his classroom.

Secondly, Mr. Mills saw value in providing the scaffolds to all of the students in his room. During coaching conversation #16 while he was reflecting on the scaffolds he had been providing to his students, Mr. Mills stated, "I think that for the English language learners seeing the English language speakers be forced to do the same thing as what they have to do, I think that matters…I think that for confidence." Mr. Mills felt that requiring all of his students, including the native English speakers, to use the same sentence starters created a climate in the classroom that allowed for his ELL students to not feel singled out.

Reflection on academic language and scaffolds. The third theme that emerged from the analysis of Mr. Mills' processes while planning scaffolds for science academic

language was his engagement in reflection on academic language in general, as well as his students' use of the scaffolds that he had been planning and implementing. During these conversations, Mr. Mills' reflection focused on three areas: his frustration with academic language, the use of the scaffolds by the students in his class, and describing how he was applying the learning from the teaching experiment to other classes and grade levels.

Frustrations with academic language. During the reflective conversations that occurred within the coaching conversations, Mr. Mills voiced frustration with academic language, particularly the level of language expectations that often seemed to be placed on students, as well as how to balance language instruction with the science content that he was responsible for teaching. Mr. Mills very much saw himself as a science teacher and felt it was his job to focus mostly on science content and less on language teaching. He saw his role as different from that of the ELL teachers:

> And I guess the problem for me is I'm struggling with, when you talk to the ELL teacher; their job is to teach English through the content. I'm trying to get them to learn the content without much English. And I'm not trying to teach them English per se you know what I mean? (Coaching Conversation #2, 2/24/17)

Mr. Mills was very much focused on the science content that he was responsible for teaching his students and felt that it was most important for him to focus on that content with his students. He echoed this sentiment again when we discussed the Dutro and Moran (2003) framework:

I think it's kind of the way I get in the argument with the with the literacy people all the time I'm not a reading teacher, right. I don't learn to read in my classroom, we read to learn. (Coaching Conversation #12, 4/20/16)

Some of Mr. Mills' frustrations with supporting language stemmed from district trainings he had attended that were focused on supporting ELL students and he often felt the language that those trainings focused on were not appropriate for elementary students. During coaching conversation #12 (4/20/16), while discussing the Dutro and Moran (2003) framework, Mr. Mills connected to an example he had shared with me prior to starting the classroom teaching experiment where he had participated in a professional development focused on passive voice (Extract 5).

Extract 5 – Coaching Conversation #12 – 4/20/16

79	Mr. Mills	Well it was like
80	Karl	It's kind of like how we've talked about the past with like passive voice right?
81	Mr. Mills	That's literally what I just was going to say the 25 milligrams of salt was added
82		versus I had 25 milligrams of salt. The part that I struggle with is not only are we
83		dealing with English language learners, we're dealing with young kids who overall
84		don't have that level of language and it's like the same thing with their math lessons
85		when you force this high-level crap on them, they don't have, it's like you know I just
86		want them to tell me what they did to begin with. And it's like what's the huge deal if
87		they say, "I added twenty-five milligrams of salt," when they're six years old versus
88		you know, "twenty-five milligrams of salt was added". I'm not gonna get all caught
89		up in arms about that!

In this extract, Mr. Mills is sharing the frustrations and tensions he was feeling with the language that he felt his students needed, compared to the language was being emphasized in the professional development experiences he engaged in. The specific professional development that he is referencing discussed a science experiment that involved students adding 25 milligrams of salt to a cup of water, and was focused on having students use passive voice. Mr. Mills felt a focus on this type of language was not only challenging for students because they are English language learners, but also

because they are children who are not yet ready to focus on that level of language (Line 3).

Another example that illustrates Mr. Mills' frustrations with language expectations came while we were developing sentence starters to support his students in having a design conversation during the wind turbines unit. During the design conversations, the students were to select one of the six possible blade designs that they came up with and share it with their classmates, explaining why they thought it would be a good design for catching the wind. Mr. Mills and I decided to scaffold these conversations by providing the students with a series of sentence starters that they could use to ask questions about each other's' designs and to share their ideas about why their designs would be effective. We planned these scaffolds during coaching conversation #17, and while planning for this design conversation, we looked at the *Constructive Conversation Skills Poster* (Zwiers, O'Hara, & Pritchard, 2014), one of the resources I had provided Mr. Mills earlier in the teaching experiment. As we looked through this resource, I read one of the sentence starters, "The negatives of _____ outweigh the positives of _____." Mr. Mills responded to this sentence frame by stating, "Yeah nobody talks like that." While this resource was not necessarily designed specifically for elementary students, this again highlights the tension that Mr. Mills felt with the language expectations that were placed on students. He felt that this example was not characteristic of the ways that people talked and therefore did not see it as a reasonable expectation for students.

Student use of the scaffolds. The second trend that emerged from the reflection that occurred during the coaching conversations was Mr. Mills' reflection on his students

use of the scaffolds. Throughout the teaching experiment, part of our coaching conversations focused on reflecting on the scaffolds and instructional strategies that Mr. Mills was planning for and implementing in his classroom. This reflection at times was more structured, involving the examination of student work examples or using video to examine the ways in which students were talking during the lessons, while other reflective conversations were less structured, occurring through Mr. Mills' discussion of the things he saw happening in the class and how he felt it was scaffolding his students' language.

In the lesson before coaching conversation #4 (3/10/16), Mr. Mills provided his students with a word bank of terms to support their descriptions of how their redesigned tool worked better or worse than their initial design. When Mr. Mills implemented this word bank with his students, I modeled posting sentence starters for his students. In doing this, I shared two possible sentence starters that the students could use to write their descriptions, "Our tool worked better because _____." and "Our tool didn't work better because _____." Mr. Mills led a quick discussion with the students to explain how the sentence starters were possibilities the students could use, but that they did not have to use those exact sentences. He provided this choice because the goal of the sentence starters was not necessarily to have all the students produce the exact same sentence, but to provide them with an understanding of the structure of responses the students were expected to provide. During coaching conversation #4 (3/10/16), which followed this lesson with the word bank and sentence starters, Mr. Mills and I examined the ways in which students had used two sentence starters during the previous lesson, and reflected

on how the students had used the sentence starters by looking at the writing they had completed (Extract 6).

Extract 6 – Coaching Conversation #4 – 3/10/16

26	Mr. Mills	There you go. ((reading student response)) "It worked better because it can actually
27		pull it apart and the first one only scooped out sand and gravel." That was that one
28		group that did a complete wrong design the first time.
29	Karl	Yeah
30	Mr. Mills	Yeah, it's the same group, "because it can pull apart the tree this time", okay the
31		same thing, the same thing.
32	Karl	Which you'd expect because they were talking
33	Mr. Mills	Yeah, well we told them they could talk to each other. ((reading another student
34		response)) "Our tool worked more better because we added more holes and the sand
35		went faster."
36	Karl	((reading student response)) "The other one didn't even pick up the tree."
⋮		
48	Karl	…so what did you think?
49	Mr. Mills	I thought it was good, I mean, that's good stuff. You can see the sent-[ence starters],
50		I mean [the sentence starters] helped them. I think the explanation that we did,
51		helped them. It was very clear.
52	Karl	It gave them an idea of what we wanted.
53	Mr. Mills	Exactly.

As we examined the student writing, Mr. Mills read through the responses that groups of students had written, with many of the students using the sentence starters that we had provided (Lines 26-36). I then asked him what he thought (Line 48) and he reflected on how the scaffold supported the students (Lines 49-51). Mr. Mills felt that by providing the sentence starters, and the explanation that we provided while introducing them, really helped his students have a clear idea of what was expected in answering the questions. This conversation followed the first time that sentence starters were implemented within the teaching experiment and set the stage for the consistent planning and implementing of sentence starters throughout the remainder of the teaching experiment. As discussed above, following this conversation, Mr. Mills focused his planning of scaffolds almost entirely on using sentence starters to support his students in understanding the types of science related responses he was expecting.

Applying to new situations. The final trend that emerged from Mr. Mills' reflections on academic language and the scaffolds he was implementing was the application of the scaffolds to new situations. In an instructional coaching partnership, one of the most important goals is the incorporation of instructional strategies by teachers into their broader teaching, beyond simply the context that is the focus of the coaching partnership (Knight, 2009). For this study, the hope was that by engaging in the coaching partnership, Mr. Mills would apply the scaffolds for science academic language beyond simply the 5th grade Language Academy class, but to his other classes as well. This theme presents the ways in which Mr. Mills was consciously utilizing scaffolds for academic language in other settings, and how he discussed that utilization through his reflection.

As the teaching experiment progressed, Mr. Mills discussed a few different ways that he was applying the scaffolds to new situations. One of the ways that Mr. Mills applied the work we did during the teaching experiment to new situations was in using the types of scaffolds he was planning with other classes and grade levels. Twice toward the end of the teaching experiment Mr. Mills shared with me examples of how he was using sentence starters with the other grade levels that he taught. In both cases, Mr. Mills had prepared for these lessons without my support because this was not the group of students we were focused on. However, in doing so generated sentence starters that he then provided to his students during the lesson. For example, in coaching conversation #19 (5/23/16), Mr. Mills shared how he had provided a sentence starter for his third-grade students to scaffold their observations of rock and mineral textures (Extract 7).

Extract 7 – Coaching Conversation #19 – 5/23/16

3	Mr. Mills	Oh look, [I'm] doing it in my third-grade class too.
4	Karl	I see that.
5	Mr. Mills	And it worked really well, this is with the ELL for third grade.

6	Karl	Okay.
7	Mr. Mills	So [we were] talking about hardness, luster, streak, color, texture. They remembered
8		the word properties which was really nice.
9	Karl	Oh good.
10	Mr. Mills	((showing 3rd grade Promethean slides)) And then we did things with the rocks at
11		their tables and, this is for the texture. ((reading prompt and sentence starter)) "How
12		does the rock or mineral feel? When I touch the rock or mineral it feels…" We had
13		[listed] a couple of words, [I had the students] give me some words that talk about
14		how things feel, [like] smooth, rough, bumpy [and] they kind of got it from that.

During this conversation, Mr. Mills was sharing how he had applied the sentence starters to his third grade language academy class. In this lesson, his third grade students were observing different rocks and minerals and describing how they felt. To support his students in doing this, Mr. Mills shared that he provided his third graders with a sentence starter on the Promethean board, "When I touch the rock or mineral it feels…" and then he and the students came up with a few words together to describe how the rocks or minerals felt. The sentence starter that he provided to the third grade students was very similar to the sentence starters he had been providing to the fifth grade students who were the focus of the teaching experiment, and there was explicit indication from Mr. Mills' reflection that he recognized the value of scaffolding academic language and providing sentence starters beyond the 5th grade Language Academy class.

The other way that Mr. Mills began applying the types of resources and scaffolds to other situations was in the work he did with the pre-service teachers who taught in his classroom. During coaching conversation #16, Mr. Mills shared with me that as he talked with the pre-service teachers, and supported them in planning the lessons they would teach in his room, he would focus on some of the same language scaffolding techniques with them as we were in our conversations.

> It's funny because you are telling me this and I am telling the same kind of stuff to the [student teachers]. I've been showing them the worksheets we've been making because [the student teachers] have been saying, "go ahead and go back to your table [and] make some observations." And [the students] go back to their table and they go "what?" But then I say look, if you take this back [and] you give them a prompt on their sheets saying, "When I poured the water through the gravel I observed…" So then they have to say that. Because you can't just say to kids, make an observation because they [might not remember how]. (Coaching Conversation #16, 5/11/16)

Mr. Mills was sharing how the pre-service teachers would tell the students to go make observations, but that the students would not know what to write or say because the pre-service teachers were not making clear to the students what they were expecting. As a result, Mr. Mills shared that he was sharing the worksheets we had been creating with the pre-service teachers to encourage them to include sentence starters that helped the students know what types of responses they were expected to provide when making observations.

Resources that assisted Mr. Mills' planning of scaffolds for science academic language. The third aim of this study was to understand the types of resources that assisted Mr. Mills in scaffolding for science academic language, with the hope of developing a beginning understanding of how teachers can be supported in this type of work. This section describes the resources that assisted Mr. Mills in his planning of scaffolds for science academic language and reflects on the coaching partnership as a process, as well as my role and actions as a coach within that partnership.

When examining the resources that assisted Mr. Mills during the classroom teaching experiment, unsurprisingly the coaching partnership emerged as the primary resource that assisted Mr. Mills. Specifically, it was the utilization of the partnership principles as we engaged in that partnership that created opportunities for Mr. Mills to plan and implement scaffolds for science academic language. In the following sections, I first describe the coaching partnership that Mr. Mills and I engaged in, and what a typical coaching session between he and I looked like, after which I further explore how the utilization of the partnership principles created opportunities for Mr. Mills to plan and implement scaffolds for science academic language.

The coaching partnership: Underlying structure and procedures. The coaching partnership that Mr. Mills and I engaged in was designed with Knight's (2007/2009) partnership principles (hereafter referred to only as "partnership principles") in mind to provide Mr. Mills a space to focus on academic language and develop his knowledge and skills in scaffolding language in his classroom. The seven partnership principles are: *equality*, *choice*, *voice*, *dialogue*, *reflection*, *praxis*, and *reciprocity*. These partnership principles are briefly summarized in Table 4.2 (for a more complete description of the partnership principles refer to Table 2.3). When Mr. Mills and I met for each coaching conversation, I, as a coach, utilized the partnership principles to provide support to Mr. Mills based his needs at that time.

Table 4.2

Knight's (2007) Partnership Principles

Partnership Principle	Overview of principle
Equality	"Instructional coaches and teachers are equal partners." "Instructional coaches listen to teachers with the intent to learn, to really understand, and then respond, rather than with the intent to persuade."

Choice	"Teachers should have choice regarding what and how they learn." "Teacher choice is implicit in every communication of content and, to the greatest extent possible, the process used to learn the content."
Voice	"Professional learning should empower and respect the voices of teachers." "Instructional coaches…encourage teachers to express their opinions about content being learned."
Dialogue	"Professional learning should enable authentic dialogue." "…they listen more than they talk. Instructional coaches avoid manipulation, engage participants in conversation about content, and think and learn with participants."
Reflection	"Reflection is an integral part of professional learning." "Instructional coaches encourage collaborating teachers to consider ideas before adopting them."
Praxis	"Teachers should apply their learning to their real-life practice as they are learning." "Instructional coaches …focus their attention on how to use ideas in the classroom as those ideas are being learned."
Reciprocity	"Instructional coaches should expect to get as much as they give." "…an instructional coaches' goals should be to learn along with collaborating teachers, such as learning about each teacher's classroom, the strengths and weaknesses of the teaching practices being learned when used in each teacher's classroom…"

Our coaching conversations took place over Mr. Mills' preparation hour, which also included his lunch break. Each meeting, we sat down to our conversations over lunch, with myself bringing my lunch to eat along with Mr. Mills. These conversations routinely started with me asking Mr. Mills what was happening that day in the class, and Mr. Mills providing an overview of what he was going to be sharing with the students and what the lesson entailed. After that overview, we typically examined some of the talk and/or writing that his students needed to use in the lesson, and then planned and prepared scaffolds for Mr. Mills to provide to his students. As we worked through examining these activities, I utilized the partnership principle of *voice*, and asked Mr. Mills questions to have him explain the types or responses he was expecting from students, or how he envisioned the activity taking place. This allowed him to express his ideas and opinions about the language his students needed to use during these coaching conversations. I utilized the partnership principle of *choice*, and was conscious of how I

presented specific scaffolds to Mr. Mills with the goal that him not feeling like he had to use the specific scaffolds I suggested. Instead, I focused on providing him space to think about what might work, encouraging him to develop specific scaffolds that he felt would work for him in his setting, utilizing the partnership principles of *praxis* and *dialogue*. Our conversations would typically lead to the modification, or generation of, a student worksheet that would be used with the target class.

Utilization of the partnership principles created opportunities for Mr. Mills to plan and implement scaffolds for science academic language. There were two salient ways in which the utilization of the partnership principles created opportunities for Mr. Mills to plan and implement scaffolds during the classroom teaching experiment: 1) the utilization of the partnership principles created opportunities for Mr. Mills to discuss academic language and its use by his students, and 2) the utilization of the partnership principles created an opportunity for Mr. Mills to observe the modeling of how a specific scaffold, sentence starters, could be used to scaffold student language use. Each of these will be discussed, highlighting the specific partnership principles, and how they were utilized to create opportunities for Mr. Mills to plan and implement scaffolds for science academic language.

Utilization of partnership principles to create opportunities to discuss academic language. The partnership principles were utilized within the classroom teaching experiment to create opportunities for Mr. Mills to discuss academic language in two main ways. The first created opportunities for Mr. Mills to articulate his expectations for student language use. As was discussed in the findings of Mr. Mills' processes while planning, it was important for Mr. Mills to articulate his expectations for student

language use prior to his identification of the scaffolds that he could provide to his students. This articulation of language expectations was facilitated utilizing the partnership principles, specifically the principles of *voice* and *dialogue*. These principles were used frequently across the classroom teaching experiment to assist Mr. Mills in planning scaffolds, with their use occurring in 13 of the 16 coaching conversations in which we generated scaffolds for science academic language.

An example of this comes from coaching conversation #13 (4/27/16), in which Mr. Mills was creating the student worksheet for a lesson on heat transfer. As he was creating this sheet, I posed the following question, "Yes, so what are you thinking of for responses?" (Coaching Conversation #13, 4/27/16) By asking this question, I was utilizing the principle of *voice*, and providing Mr. Mills with the space to share and articulate his thinking about the language his students would be using. This prompting of Mr. Mills to articulate his language expectations also facilitated the utilization of the principle of *dialogue*, allowing us to engage in conversation about the content his students would be talking about and the language he expected them to use. After asking Mr. Mills what he was expecting for responses, we had the following exchange (Extract 8):

Extract 8 – Coaching Conversation #12 – 4/20/16

194	Karl	Yes, so what are you thinking of for responses?
195	Mr. Mills	Well for these I just want to know if it feels cold or…
196	Karl	Yeah
197	Mr. Mills	Yeah that's fine.
198	Karl	But so like these ((pointing to prompt at the bottom of the page))
199	Mr. Mills	Down here, the material that made the ice melt the fastest was. Or the ice melted the
200		fastest in blank because
201	Karl	Okay so they need to have that evidence then to say why.
202	Mr. Mills	That's why there's numbers.
203	Karl	Okay, so hopefully they are using their data.
⋮		

209	Karl	So, they know that that's the data table they should be using So, ((reading off
210		worksheet)) "Use the data table above. Which material made the ice melt the
211		fastest? How do you know?"
212	Mr. Mills	Is it really a how do you know or is it a prove it?
213	Karl	I mean, I think how do you know makes sense and you would say, "because it
214		melted fastest in the foil", right? [or] "because it lost the most", right?
215	Mr. Mills	I just make sure they're not going to -- or I kinda want them to say -- nah we're not
216		going to get to it, but the foil -- the felt insulated, that's not going to happen though.
217	Karl	Why not?
218	Mr. Mills	You think? I mean…
219	Karl	I mean I think it could happen. I think that's the next step beyond this, right? To say
220		which is the best insulator.
221	Mr. Mills	So, it could be like, the ice melted fastest in nothing, the plain ice, because
222		it was sitting on the table and the table made it melt. They're not going to say, the
223		ice melted fastest in the ice or plain ice or on the table because it lost as much
224		weight. We have to be specific about what we want them to say they can go either
225		way with that. They can say, because it was on the table or because it lost four point
226		eight grams or whatever.

This conversation is an example of the utilization of the partnership principle of *dialogue* because Mr. Mills and I had equal stakes in the conversation, and explored ideas together related the science content that his students would be engaging with and what his students might say in response to the prompts that Mr. Mills was planning to provide.

The second way that the partnership principles were utilized to create opportunities to discuss academic language was through the use of the partnership principles of *reflection* and *voice*. These partnership principles were utilized to facilitate Mr. Mills' reflections on academic language use in the science classroom, as well has his frustrations with supporting language use in his classroom and during science instruction. The following examples were discussed above in detail in the discussion of Mr. Mills' frustrations with academic language, and were facilitated and made possible by utilizing the partnership principles of *reflection* and *voice*:

> I'm trying to get them to learn the content without much English. And I'm not trying to teach them English per se you know what I mean? (Coaching Conversation #2, 2/24/17)
>
> The part that I struggle with is not only are we dealing with English language learners, we're dealing with young kids who overall don't have that level of language and…you force this high-level crap on them (Coaching Conversation #12, 4/20/17)
>
> "Yeah nobody talks like that." (Coaching Conversation #17, 5/16/16)

Another example of how the principles of reflection and voice again came during coaching conversation #12 (4/20/17).

> I mean I know this is the point of your Ph.D., but I think you can do you can try this too much. You can you can try to do too much with language, like trying to enforce the language side of things…I'm going to teach them to use the right words to get their point across. But I'm not going to sit here and go through just an English language lesson with them, because that's not I'm supposed to be doing. (Coaching Conversation #12, 4/20/17)

In this instance, Mr. Mills acknowledged that he knew the goal of the research I was doing on our classroom teaching experiment was to provide students with supports for language, but while reflecting on this, the partnership principle of *voice* allowed Mr. Mills to feel comfortable enough to challenge this work that I was doing as a part of my doctoral research. He did this by sharing his opinion that "you can try to do too much with language" and that he wasn't going to "go through just and English language lesson" with his students. Were it not for the partnership principles of *reflection* and *voice*, Mr.

Mills may not have felt comfortable to share his perspectives that he felt challenged the work that I was doing.

The third way that the partnership principles were utilized to create opportunities for Mr. Mills to discuss academic language was through the use of the partnership principle of *reciprocity*. This principle was utilized and valuable when Mr. Mills and I discussed the scaffolds he was providing to his students, and he shared his perspectives of how he felt the scaffolds did or did not work for his students. These conversations of scaffolds and his students' use occurred more frequently in the latter portions of the classroom teaching experiment, occurring in coaching conversations #4, #16, #17, #18, and #19. An example of this came during coaching conversation #18 (5/18/16), when Mr. Mills and I examined video of his students using one of the scaffolds he had provided. After watching the video and discussing the use of the scaffolds, our conversation shifted to the type of scaffolds we had provided and how they could be used with other lessons or units.

Extract 9 – Coaching Conversation #18 – 5/18/16

170	Mr. Mills	Exactly. So, I think it would be great if we could do this stuff with the [mining tools
171		unit] because I think we could really work this deeper level stuff in there.
172	Karl	Yeah.
173	Mr. Mills	Like I chose this design from my tree removal tool because it will pick up the trees
174		really well. Why does it need to pick up the trees really well? Oh, because we need
175		to have a low environmental impact when we pick up the trees and don't [want to]
176		ruin the surface of the planet.
177	Karl	And how? when you say it will pick up the trees well, well how? How will it do
178		that? So, it will be able to grab them and then pull the top off, right, whatever.
179	Mr. Mills	It's still good to see them talking the way we asked them to, but it's just, maybe this
180		unit is just a little tough for them as far as the ideas behind what [makes a good
181		turbine blade].

Mr. Mills began this part of the conversation by thinking about how he could apply these types of design conversations to the mining tools engineering unit, and he felt that unit would lend itself to working in these "deeper level" (Line 170) conversations.

He then modeled an example of how he thought students might discuss their mining tools in this fashion (Lines 173-176). The conversation concluded with Mr. Mills returning to the fact that he was encouraged by seeing the students "talking in the way we asked them to" (Line 179) and that he felt the unit was simply one that was "tough for them [the students] as far as the ideas behind what [makes a good turbine blade]" (Line 180). He expressed that the content in this unit, and the students' lack of deep understanding of what was affecting how a turbine blade truly worked, was limiting the language use of his students because they did not know the concepts to be able to talk about them.

In this conversation, the partnership principle of *reciprocity* was utilized when Mr. Mills shared his thinking about how these design conversations would work better with a unit where the students would have a better understanding of the concepts, such as the mining tools unit. This insight allowed me to better understand both the scaffolds he provided to his students, as well as his perspectives about how the scaffolds could be used in another setting. His discussion of how the scaffolds could be used with the mining tools unit also utilized the principle of *praxis* because he was discussing how he could reconstruct this scaffold in a setting where he felt it would be more useful.

Utilization of partnership principles created an opportunity for Mr. Mills to observe the use of sentence starters. The partnership principles were used in one instance to create an opportunity for Mr. Mills to observe the use of sentence starters as a scaffold for science academic language. This occurred through my modeling their use in the middle of a lesson with his 5th grade Language Academy students, and utilized the partnership principles of *equality*, *praxis*, *reflection* and *reciprocity*. During the first class period that was observed, which occurred after our third coaching conversation, Mr.

Mills provided his students with a word bank to support their explanations of how their redesigned mining tool did or did not work better than their first design. This word bank had been generated through the coaching conversation, and we had discussed the possibility of providing sentence starters, but did not prepare any before the lesson. During the lesson, after Mr. Mills explained to his students that he wanted them to make a claim about whether their tool worked better or not and then support it with evidence, I stepped into the lesson to model two sentence starters that could help the students in getting started on this claim (Extract 14). I chose this moment to insert myself into the lesson because it presented a perfect opportunity to provide the students with sentence starters to scaffold their claims about how their tool worked.

Extract 10– Classroom Implementation – 3/9/16 (14:14-17:30)

1	Mr. Mills	((speaking to the class)) So this is your claim and evidence. So when we get to this
2		sheet, you're going to make a claim for me that it works better or worse than your
3		previous tool. Do you understand? And I need a solid 5th grade statement, not
4		because its better. I need to know why you think it works better. Tell me what your
5		reasoning is. This is very important to tell me why you think [it works better or
6		worse], you can certainly talk as a group, but you've got to have something solid
7		down it just can't be, because, that's not legit in science.
8	Karl	Could we write that up there? So you guys are 5th graders so I know that you can do
9		more than just say because. So with using these words, if it worked better one way
10		you might start it is your claim might be, ((writing on Promethean board)) you might
11		say our tool worked better, there's your claim right? And then because and you're
12		going to finish that sentence with your evidence, right? If it didn't work better you
13		might say, Our tool [didn't work better because…] ((I make a mistake in my writing
14		which causes students to laugh and stops my explanation))
15	Mr. Mills	Alright so here's the deal, here are some you use these all the time, sentence starters
16		okay. You can start this way, do you have to start this way?
17	Students	No
18	Mr. Mills	No but this can certainly be the way you do it.

In this lesson, I modeled how Mr. Mills could post sentence starters for his students, and how they could be used to explain the types of responses that students might be making (Lines 8-13). I did this by providing two example sentences that the students could use, and talked through how the students could use them when making the claim, and support

it with evidence, as Mr. Mills was wanting his students to do. We had not planned ahead of the lesson that I would do this and Mr. Mills did not know that I was going to insert myself into the lesson in this way. My goal in inserting myself into this lesson in this manner was to demonstrate for Mr. Mills how sentence starters could be used to scaffold language.

While this type of modeling occurred only once during the classroom teaching experiment, and was not a more common feature, it is of note for the following reasons. This type of modeling would not have been possible without the existence of a strong partnership between Mr. Mills and myself. Modeling of instructional strategies and techniques is a common feature of instructional coaching partnerships (Knight, 2007) and allows teachers to see specific strategies and techniques in action. However, this type of modeling requires a strong partnership between the teacher and the coach to ensure that both partners are comfortable taking on these roles in the classroom (Knight, 2007). Without the utilization of *equality*, *praxis*, and *reciprocity*, I would not have been able to insert myself into the lesson as I did, and I would not have been able to provide this modeling to demonstrate for Mr. Mills how sentence starters could be used. It speaks to the strength of our partnership that I could insert myself into the lesson, and Mr. Mills allowed it to happen. Additionally, after reflecting following this modeling, Mr. Mills took up the scaffolding strategy of sentence starters and carried it forward through the remainder of the classroom teaching experiment. He also adapted it to fit his needs (an example of the partnership principle of *praxis*), by evolving his expectations to the requirement that his students use the provided sentence starters, which is described in detail in the findings around Mr. Mills' implementation processes.

While engaging in the planning of scaffolds for science academic language, Mr. Mills engaged in the actions and processes described above, and was assisted in this planning through instructional coaching partnership and the utilization of the partnership principles. Following his planning of scaffolds for science academic language, Mr. Mills implemented those planned scaffolds in the classroom with his 5th grade Language Academy students. The following section presents the findings for research question 2, which examines this implementation and the actions and processes that Mr. Mills engaged in during that implementation.

Research Question 2: What actions and processes does an elementary science teacher engage in while implementing instruction that scaffolds science academic language?

In this section, I describe the actions and processes undertaken by Mr. Mills as he implemented the scaffolds for science academic language which were planned during our coaching conversations. I first describe the scaffolds that he implemented within the classroom and the language he chose to support with those scaffolds (Actions). I then describe how Mr. Mills implemented those scaffolds with his students to support their language use within his science classroom (Processes).

Actions. In this study, when examining Mr. Mills' implementation, I defined actions to denote *what* Mr. Mills implemented to scaffold science academic language in his classroom. This includes the language that Mr. Mills chose to scaffold and the types of scaffolds he implemented to support his students in the talking and writing they were required to do in his classroom. This section begins with an inventory and analysis of the scaffolds implemented by Mr. Mills throughout the classroom teaching experiment.

Following this inventory, I present two themes that emerged from the analysis of the scaffolds that Mr. Mills implemented and the language he chose to scaffold: Strict adherence to the planned scaffolds and the use of point-of-need scaffolds to support in-the-moment language use.

Inventory of scaffolds implemented during the teaching experiment. Table 4.3 provides an overview of the scaffolds that Mr. Mills implemented during the classroom teaching experiment. In all, Mr. Mills implemented 26 science academic language scaffolds. In this table, the "point-of-need" (Sharpe, 2001) scaffolds that were provided in-the-moment to scaffold student language use are in bold and the rest are scaffolds that were planned prior to the implementation.

Table 4.3

Inventory of Scaffolds Implemented in Mr. Mills' 5th Grade Class During the Classroom Teaching Experiment.

Unit	Date	#	Scaffolds Implemented
Mining Tools	3/9/16	1	Word bank to support analyzing redesigned mining tool. **Sentence starters provided by Karl during lesson.**
	3/14/16	2	**Mr. Mills reminded students of the sentence starters provided in the previous lesson and typed a variation of them on the Promethean board in the middle of the lesson.**
	3/16/16	3	Sentence starter provided on the Promethean board to support students in explaining why someone should choose to bring their tool to the alien planet to mine for resources.
Adaptations	3/21/16	4	**Verbally provided sentence starter to students when introducing the activity of identifying similarities and differences between adult animals and their offspring. Repeated and rephrased student responses during sharing out of similarities and differences.**
	3/23/16	5	Provided sentence starters on Promethean board and at table spots to support discussion of adaptations and student writing. **Repeated and rephrased student responses when sharing out the adaptations they identified.**
	3/28/16	6	Reviewed slides from previous lesson, highlighted the types of responses that were expected when describing adaptations, and provided sentence starters on the Promethean board to support students in writing about the bird beaks.
	4/11/16	7	No language scaffolds in this lesson.
State Test Review	4/13/16	8	Sentence starters provided on student worksheet to help the students make predictions about the gummy bear experiment. **Clarified what a variable is in science vs. a variable in math.**

	4/18/16	9	Sentence starters provided on student worksheet to help the students make observations about the gummy bear experiment. **Added the sentence starters to a Promethean slide before having the students share so the sentence starters were up on the board for the students.**
	4/20/16	10	Sentence starter on student sheet about levers, required this sentence starter when students shared their ideas. **Verbally provided sentence starter in the lesson to help students answer a question about the lever activity.**
	4/27/16	11	No language scaffolds in this lesson.
Wind Turbines	5/9/16	12	Sentence starters provided on the Promethean slides at the beginning of the lesson to support predictions, observations, and explanations. Sentence starters provided on student worksheet to support their writing while recording information from reading on wind turbines. Sentence starter provided on Promethean board used at end of lesson to have students share things they wanted to control when designing a wind turbine blade.
	5/11/16	13	Sentence starter provided on Promethean board to have students share the things they are controlling when designing the wind turbine blade. Sentence starter provided on the Promethean slides to support students in sharing what the job of a wind turbine blade is. Sentence starter provided on the bottom of the design worksheet to support students in explaining why they chose their design.
	5/16/16	14	Revisited the sentence starter for what to control when making a wind turbine blade again, required use of sentence starter posted on board. Sentence starters to support design conversations posted on board. **Karl suggested modeling during the lesson and we modeled a conversation for the students using the sentence starters.**
	5/18/16	15	No language scaffolds in this lesson.
	5/23/16	16	No language scaffolds in this lesson.
	5/25/16	17	Sentence starters provided to students on worksheet to support their final design analysis of their wind turbine blades and the redesigning of their blade.

Table 4.3 shows that Mr. Mills implemented scaffolds for science academic language across 13 of the 17 class periods that were observed. These scaffolds included a combination of planned scaffolds and "point-of-need" scaffolds. "Point-of-need" scaffolds were unplanned scaffolds that were provided to support students with in-the-moment language use. Mr. Mills implemented planned scaffolds in 11 of those 13 class periods that included language scaffolds, and implemented point-of-need scaffolds in 8 of those 13 class periods.

Trends in Mr. Mills' implementation of scaffolds. The examination of the scaffolds that Mr. Mills implemented show that, similar to his planning of scaffolds, sentence starters were heavily emphasized during implementation. Of the 26 scaffolds listed in the table above, 20 of those scaffolds were sentence starters, including five instances when sentence starters were provided as point-of-need scaffolds. Beyond sentence starters, Mr. Mills also implemented other scaffolds for science academic language which included word banks, modeling, rephrasing student responses, repeating student responses, and vocabulary instruction to clarify science terms. These scaffolds were all strategies for scaffolding that were discussed during the coaching conversations, with the exception of repeating student responses.

When examining Mr. Mills' implementation of scaffolds over time, two trends emerged. First, while he primarily used sentence starters as the science academic language scaffold of choice, Mr. Mills demonstrated more variety in his implementation of scaffolds earlier on (first 5 lessons) than later in the classroom teaching experiment (last 12 lessons). This mirrored his planning of scaffolds during the coaching conversation, which emphasized sentence starters following their introduction. Secondly, by the final unit of the teaching experiment, Mr. Mills implemented fewer point-of-need scaffolds during his lessons. This reduction coincided with a higher number of scaffolds planned by Mr. Mills during the Wind Turbine unit. The following section examines the two themes that emerged when investigating these scaffolds that Mr. Mills implemented to support science academic language. The first of these themes was Mr. Mills' strict adherence to the scaffolds planned through the coaching conversations, and the second

theme focuses on Mr. Mills' use of point-of-need scaffolds to support in-the-moment language use.

Strict adherence to the planned scaffolds. When examining Mr. Mills' implementation of scaffolds for science academic language, the first theme that emerged was his strict adherence to the scaffolds that he planned through the coaching conversations. During his classroom instruction, Mr. Mills implemented every scaffold that was planned during the coaching conversations, and did so with fidelity to the original plan. He successfully applied and implemented those scaffolds planned during the coaching conversations, and used them to support his 5th grade Language Academy students in their discussions or writing during his science lessons.

As an example, during coaching conversation #17 (5/16/16) Mr. Mills planned for a lesson in the wind turbines unit in which the students were to have a conversation around the design of their wind turbine blades. In this conversation, Mr. Mills planned to provide his students with a set of sentence starters to help his students to scaffold their design conversations (Figure 4.5).

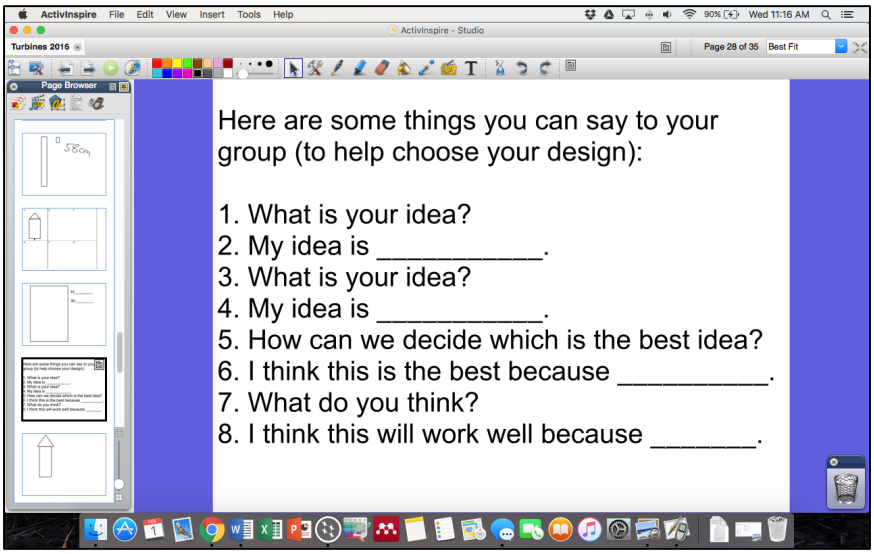


Figure 4.5. Sentence starters planned to scaffold student design conversations.

While discussing this scaffold, Mr. Mills noted that he would post the sentence starters on the board and would tell his student to, "Use the sentences on the board to guide your conversation" (Coaching Conversation #17, 5/16/16). Following this coaching conversation, Mr. Mills implemented those sentence starters with his students that afternoon, and introduced those scaffolds in the following manner:

> So you [will] go to your table, [and] how many shapes do you draw? ((students shout out six)) Six. Then you're going to look at all your shapes and to yourself, in your brain you're going to say, "Which one do I think is the best that I drew?" Okay, understand? It says right down here [on the worksheet], "Come up with six, pick your favorite to share with your group." So you're going to pick one to share with your group that you're going to talk to them about to try to get them to choose that one. I'm going to have some sentences on the board like this ((changes slide to sentence starters)), that will help you choose and defend your

design choices…and you have to use these questions ((pointing to board)) to choose your design [as a group]. (Classroom Implementation #14, 5/16/16)

In this excerpt, Mr. Mills applied sentence starters he had planned during the coaching conversation, and did so in a manner that matched what he discussed in the coaching conversation. During this implementation, while Mr. Mills was explaining the activity to his students, he posted the sentence starters on the board and told his students that they needed to use them while deciding as a group which design they wanted to use.

This type of adherence to the planned scaffolds was characteristic of Mr. Mills implementation, and was seen across the lessons that were observed during the teaching experiment. It is likely that a contributing factor to this strict adherence was the way in which he prepared the scaffolds during the preceding coaching conversations. Mr. Mills typed planned scaffolds directly onto the student worksheets, or included them on the Promethean slideshows he developed to guide his students through the lessons. By creating the scaffolds in this way, Mr. Mills was able to implement the scaffolds with fidelity to how he had planned to use them.

Use of point-of-need scaffolds to support in-the-moment language use.

As described above, Mr. Mills implemented all the scaffolds he planned during the coaching conversations; however, these were not the only scaffolds that he provided for his students during his lessons. In many of the lessons observed during the teaching experiment, Mr. Mills provided "point-of-need" (Sharpe, 2001) scaffolds for his students that supported their in-the-moment language use. "Point-of-need" scaffolds are contingent on teachers identifying moments during a lesson when additional support

could be useful, and can include a variety scaffolds such as repeating student responses, rephrasing student responses into more academic forms, or questioning (Sharpe, 2006).

Mr. Mills provided more point-of-need scaffolds during the first three units of the teaching experiment while providing very few point-of-need scaffolds during the final unit. In total, there were point-of-need scaffolds provided to the students in 8 of the 17 class periods that were observed during the teaching experiment. In two of these class periods, I initiated the point-of-need scaffolds, first when modeling sentence starters in the 1st classroom implementation (3/9/16), and then when suggesting Mr. Mills that I model the design conversations he wanted his students to have about their wind turbine blades during the 14th classroom implementation (5/16/16). When providing point-of-need scaffolds to his students, Mr. Mills used a variety of strategies that varied in the explicitness with which they drew attention to the language the students were expected to use, and these scaffolds included: verbally providing sentence starters, posting sentence starters on the promethean board, rephrasing student responses, repeating student responses, and clarifying science vocabulary terms. The following sections discuss the point-of-need scaffolds that Mr. Mills provided, beginning with those point-of-need scaffolds that explicitly drew students' attention to language, followed by those point-of-need scaffolds that did so in a more implicit manner.

Explicit point-of-need scaffolds. Mr. Mills provided his students with point-of-need sentence starters that were aimed at drawing his students' attention to the types of language they were expected to use. In four of the class periods observed, Mr. Mills provided his students with sentence starters that were not planned prior to the class period. For example, during the 9th classroom implementation (4/20/16), which occurred

during the state test review unit, Mr. Mills was teaching a lesson on levers. When introducing his students to levers, he first reviewed the science concept of work. During this review, he had the following exchange with the students in his class (Extract 8).

Extract 11 – Classroom Implementation #9 – 4/18/16 (39:20-40:00)

1	Mr. Mills	Who can read this one for me? Katie?
2	Katie	What is work? Work is done when force is applied and it causes an object to move.
3		The little man trying to push the house was not doing work because the house was
4		not moving. Is this pitcher doing work?
5	Mr. Mills	Is the pitcher doing work?
6	Students	Yes
7	Mr. Mills	Why? How do you know the pitcher is doing work? ((students try to blurt out)) No,
8		shh, "The pitcher is doing work because…" Allie?
9	Allie	The pitcher is doing work because, um because the ball is moving.
10	Mr. Mills	The ball is moving. Absolutely! Great job, Allie.

From this exchange, we can see how Mr. Mills provided point-of-need scaffolds that drew explicit attention to the types of language he expected his students to use. In this instance, Mr. Mills asked his students how they knew that the pitcher was doing work, and as the students started to blurt out responses, he stops them and then verbally provides them with a sentence starter to make clear how he wanted them to answer that question, "The pitcher is doing work because…" (Lines 7-8). We then see that his student, Allie, when called on to answer this question, used that structure in providing her response, "The pitcher is doing work because, um because the ball is moving" (Line 9).

Another instance when Mr. Mills implemented explicit point-of-need scaffolds came during the second classroom implementation (3/14/16), when the students were evaluating their redesigned mining tools. In the first classroom implementation (3/9/16), I modeled posting two sentence starters for the students to use when writing descriptions of how their redesigned tool worked better or worse than their first design when mining on Earth. In the second classroom implementation, the students tested their redesigned

mining tool on the alien planet, and completed a writing task in which they described how their redesigned tool worked on the alien planet. The students were responding to the prompt, "How did your tool work on Andoddin [the alien planet]?" While the students were working at their tables, Mr. Mills stopped the students, called back to the sentence starters that had been provided in the previous lesson, and posted slightly revised versions of the sentence starters on the board for the students to use to complete their writing (Figure 4.6):

> So it says, how did your tool work on Andoddin [the alien planet]? And you want to know what answer I do not want to see? I do not want to see this answer. I'm going to write it for you ((writing on board "It worked okay")). That I do not want to see. What grade are you in? ((students shout out 5th)) Remember we have those sentences from that last time, and I'll put it up there. ((typing on promethean board)) We have, "My tool worked well because…" or "My tool did[n't] work well] because…" Understand? (Classroom Implementation #2, 4/16/16)

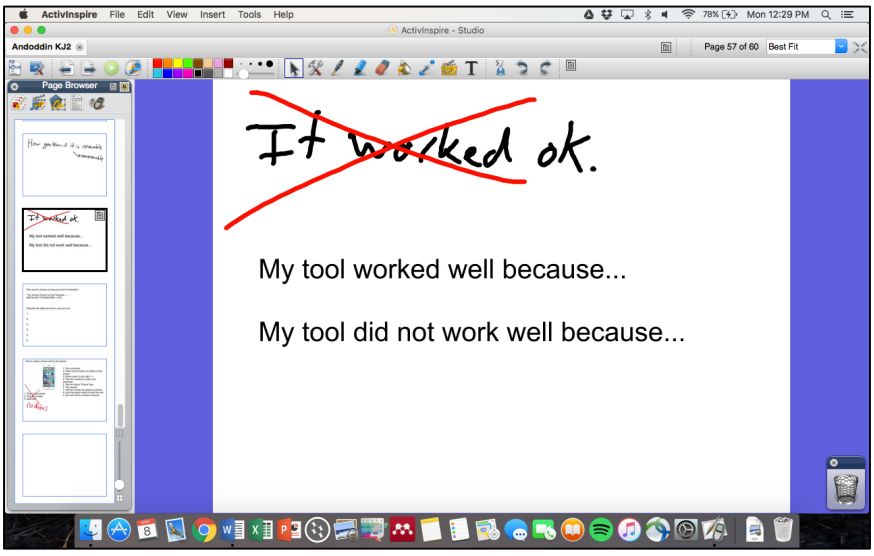


Figure 4.6. Point-of-need sentence starters provided during mining tools lesson.

In this example, we see that Mr. Mills took this moment to do two things. First, he clarified for his students his expectations for their language use by explaining that he did not want to see responses like, "It worked okay." Secondly, he then went on to provide students with the sentence starters as a point-of-need scaffold that explicitly drew attention to how Mr. Mills expected students to respond to this prompt, and to show that he expected details about why their tool worked well or not on the alien planet.

These two examples are instances when Mr. Mills provided scaffolds to his students that he had not planned for prior to the lesson. They were also instances where Mr. Mills wanted to draw explicit attention to the language he wanted his students to use, and how he expected them to produce their responses to the prompts or questions he was providing. By providing his students with these point-of-need sentence starters, Mr. Mills accomplished one of two things. In the first instance, Allie used the verbally provided sentence starter to produce not only a correct response, but a response that met Mr. Mills' expectations for the prompt. And in the second instance, Mr. Mills' discussion with his students of the types of responses he wanted in their writing possibly made his expectations clearer to his students which may have allowed them to more successfully complete the writing prompt.

Implicit point-of-need scaffolds. In contrast to the explicit point-of-need scaffolds, Mr. Mills also used point-of-need scaffolds that drew students' attention to the language they were expected to use in a much more implicit manner. These scaffolds included rephrasing student responses, repeating student responses, and clarifying science vocabulary terms. These strategies, also known as mode shifting and recasting (Gibbons, 2003), mediate student language use and development by highlighting appropriate

language use. However, these scaffolds did not directly draw students' attention to how they were expected to use language, but instead allowed students to hear desired language forms and structures.

When implementing implicit point-of-need scaffolds, Mr. Mills used the strategies of repeating and rephrasing in 2 of the 8 class periods where he used point-of-needs scaffolds, both occurring during the "adaptations" unit. Repeating and rephrasing are strategies that can support students language use and development highlighting desired language use (Zwiers, 2014). Repeating is the practice of restating a students' response and can be done at times to "emphasize its [the student's response] importance or highlight the vocabulary or grammar the student used" (Zwiers, 2014, p. 66). It allows language learners the opportunity to hear a response a second time and teachers can emphasize specific aspects by gesturing or changing the inflection in their voice to highlight specific words. Rephrasing (also known as recasting) is the process in which a teacher corrects slight errors in student responses, while still maintaining the content and meaning of that student response (Zwiers, 2014). This allows students the opportunity to "hear their own words being used in new academic frames" (Zwiers, 2014, p. 66).

In the two class periods that Mr. Mills used these strategies, he did so during the student sharing that took place at the end of each class period. For example, during classroom implementation #5 (3/23/16), Mr. Mills engaged his students in an activity where they examined pictures of animals, and identified an adaptation on that animal by naming a structure, its function and why the animal needed that adaptation to survive. At the end of the activity, the students shared the adaptations they had identified during the

activity, which led to opportunities for Mr. Mills to either repeat or rephrase student responses (Extract 9).

Extract 12 – Classroom Implementation #5 – 3/23/16 (35:20-42:25)

16	Mr. Mills	Alright how about the walking stick bug, Vincent?
17	Vincent	The color of the walking stick help it to predators not look him.
18	Mr. Mills	Yeah, the walking stick's color helps so the predators can't see him, right? Yeah
19		good job. How about one more for the walking stick. Adam?
20	Adam	The walking stick has its camouflage to stay away from predators.
21	Mr. Mills	The walking stick has camouflage to help it stay away from predators. Perfect.
⋮		
40	Mr. Mills	How about the turtle shell? Oh Holly, turtle shell.
41	Holly	The turtle has a shell so it can protect itself.
42	Mr. Mills	The turtle has a shell so it can protect itself, right? It's like armor.

In this extract, we see that Mr. Mills called on the first student, Vincent to share the adaptation that he had identified for the walking stick bug, and Vincent shared his idea, "The color of the walking stick help it to predators not look him" (Line 17). Vincent was one of the ELL students in Mr. Mills classroom, and after Vincent shared, Mr. Mills rephrased this idea into a clearer sentence, while still maintaining Vincent's idea, "The walking stick's color helps so the predators can't see him" (Line 18). Mr. Mills then called on Adam to share another example for the stick bug, in which Andrew stated, "The walking stick has its camouflage to stay away from predators" (Line 20), which Mr. Mills very slightly rephrased by stating, "The walking stick has camouflage to help it stay away from predators" (Line 21). After a few more students shared, Mr. Mills then called on Holly to share about the turtle shell, who stated, "The turtle has a shell so it can protect itself" (Line 40), which Mr. Mills repeated Holly's response exactly as she said it (Line 41).

By repeating and rephrasing the student responses in this lesson as he did, Mr. Mills highlighted the types of responses that he was wanting from his students. These

repeated and rephrased responses may also have provided support to his students in understanding more grammatically correct ways to state their ideas. However, as implemented, these strategies did not draw the same explicit attention to language forms and structures as the sentence starters did, and it would have been contingent upon the students to notice the language being highlighted through the repetition and rephrasing.

Processes. In this study, when examining Mr. Mills' implementation, I defined processes to denote *how* and *why* Mr. Mills implemented the scaffolds he used in his classroom, and how he used those scaffolds to support his students in talking and writing during the science lessons. When examining his processes during implementation, two themes emerged from the data: 1) Evolving expectations of the use of scaffolds by students and 2) Scaffolds used to support specific, discrete language tasks.

Evolving expectations of the use of scaffolds by students. The first theme that emerged from the analysis of Mr. Mills' processes in implementing scaffolds for science academic language was his expectations of the use of scaffolds that were presented to the students, and how those expectations evolved over the course of the teaching experiment. In the early part of the classroom teaching experiment, when presenting his students with the sentence starters to scaffold their language use, he noted to the students that the sentence starters were options for them to use, but that they did not have to use exactly the structure that the sentence starters provided. For example, during classroom implementation #1, I modeled posting sentence starters for the students and then Mr. Mills described his expectations for how his students should use them in the following way:

> Alright so here's the deal, here are some, you use these all the time, sentence starters. You can start this way, [but] do you have to start this way? ((Students respond "No")) No, but this can certainly be the way you do it. (Classroom Implementation #1, 3/9/16)

In this instance, Mr. Mills confirmed with his students that they did not necessarily have to start their responses using the sentence starters, but that it was one way they could write their responses. Mr. Mills provided the scaffolds as options during classroom implementations #5 and #6, again noting to his students:

> "You can use this one [sentence starter], you can use this one, or you can make up your own format. These are just [there] to help you." (Classroom Implementation #5, 3/23/16)

> "Those sentence starters can help you, do you have to use exactly those? No, you can use something like that" (Classroom Implementation #6, 3/28/16).

However, after classroom implementation #6 (3/28/16), Mr. Mills stopped providing these types of qualifiers about the sentence starters being options for the students to use, and instead would simply draw students attention to the sentence starters that he had planned for them to use. For example, during classroom implementation #9 when presenting the sentence starters to scaffold his students' observations, Mr. Mills noted, "I have some sentence starters there [on the worksheet] to help you" (Classroom Implementation #9, 4/18/16). Here Mr. Mills pointed out to his students that the sentence starter was there, but did not state to his students that it was an option for them to use or just one way to get started as he had in previous lessons.

As we progressed into the later stages of the classroom teaching experiment, Mr. Mills' expectations for the use of the scaffolds evolved even further, and he began to require that his students use the sentence starters when providing their responses. Mr. Mills began expecting that his students would use the scaffolds that were posted on the board or on their worksheets, and structure their responses exactly as the scaffold provided. For example, during classroom implementation #12 (5/9/16), Mr. Mills asked his students to share the different things they could control when designing a turbine blade. Mr. Mills posted the sentence starter, "When I make a turbine blade, I want to control the _____." on the board for his students and after giving the students a chance to turn and talk, he asked for students to share in the following way, "Alright, who would like to tell me but they have to use that whole sentence. ((reading from board)) 'When I make a turbine blade I want to control the blank.'" (Classroom Implementation #12, 5/9/16). In this case, Mr. Mills was now requiring that his students use the exact sentence that he placed on the board to scaffold their language use, and was not providing them with the option to create their own sentence.

After classroom implementation #9, Mr. Mills required the use of the scaffolds he provided in 4 of the 5 lessons in which he implemented scaffolds (Classroom implementations #10, #12, #13, and #14). This shift in how Mr. Mills expected his students to use the scaffolds, and the move from presenting the sentence starters as options to requiring their use, was likely due to Mr. Mills' perceptions of the value the sentence starters had for the students in his class. During coaching conversation #16 (5/11/16), Mr. Mills and I discussed the sentence starters he had been providing to his students as we worked to plan new sentence starters that he would implement during the

next lesson of the wind turbines unit. During this conversation, Mr. Mills noted the following about the sentence starters he was providing:

> I think it [the sentence starters] allowed the students, like we've been trying to have them do, some sought of guidance. And I think, this is just my own personal thing, I think that for the English language learners, seeing the [native] English language speakers be forced to do the same thing as what they have to do, I think that matters…I think that for confidence, like it's the difference of, so you speak great English just give me the answer. Oh but you, you are learning English, so why don't you follow these sentence [starters] for me. (Coaching Conversation #16, 5/11/16)

This quote, used previously to highlight Mr. Mills' frequent planning of sentence starters, also highlights Mr. Mills' belief that requiring all of his students use the sentence starters benefitted his ELL students. He believed that by all students being required to do the same thing allowed his ELL students to build confidence in his classroom, and likely contributed to the evolution in his expectations of how his students were to use the scaffolds he provided.

Scaffolds were implemented to support specific and discrete language. The second theme that emerged from the analysis of Mr. Mills' implementation of scaffolds for science academic language was the use of the scaffolds to support very specific and discrete language during the lessons. The scaffolds that Mr. Mills provided to his students were designed to support the students in producing a specific response when answering a specific prompt or question, and the scaffolds did so by providing students with the necessary vocabulary terms or sentence structures. When using these scaffolds with his

students, Mr. Mills focused his talk around the specific response they were giving, and not the broader language skills or features that students could apply to other language tasks.

An example of how the scaffolds Mr. Mills provided his students were used to scaffold very specific and discrete language use came during classroom implementation #5 (3/23/16), while his students were engaging in the adaptations unit. In this lesson, Mr. Mills provided his students with two sentence starters to support them while identifying and describing animal adaptations (Figure 4.7).

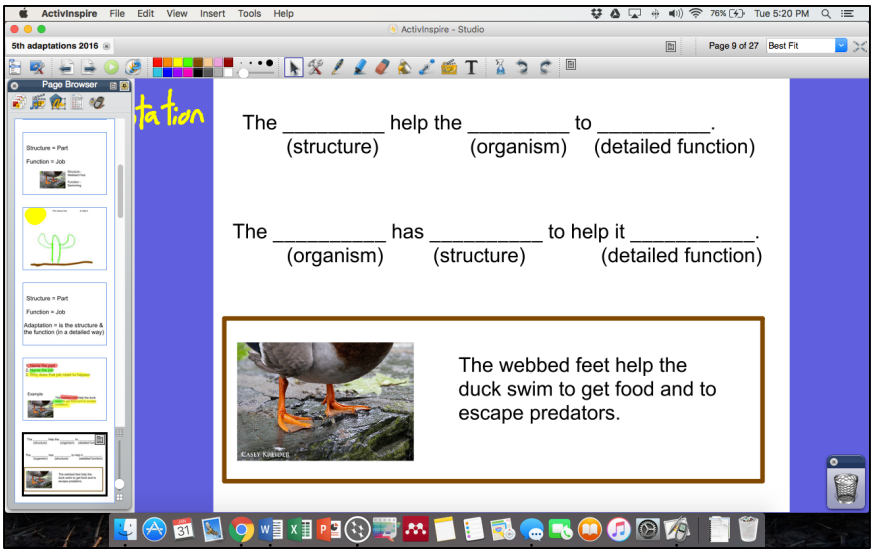


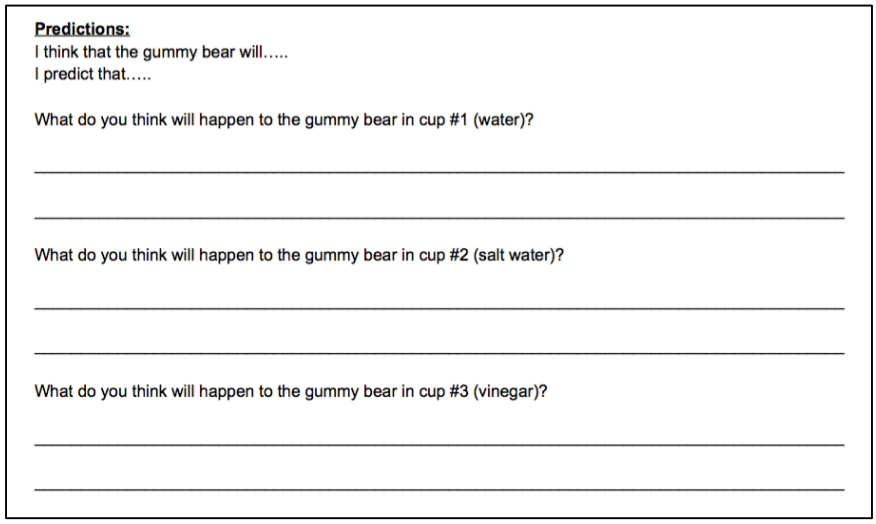
Figure 4.7. Adaptations sentence starters to scaffold student responses.

In this example, the sentence starters were designed to support Mr. Mills' students in identifying and describing adaptations on specific animals, and the students were able to use these sentence starters to successfully complete the writing and sharing, as evidenced by their shared responses: "The shark has sharp teeth to help it eat and help it catch its prey" (Tony[2]), "The turtle has a shell so it can protect itself" (Holly), and "The monkey

[2] All names are pseudonyms

has a long hand and long feet to climb up the tree" (Allie). However, these scaffolds are so specific to identifying and describing these adaptations that students are not likely to apply any language learning from these scaffolds to other language tasks, beyond perhaps understanding that they need to provide a complete sentence.

There were also instances where Mr. Mills provided his 5th grade students with less specific scaffolds. In these instances, the scaffolds were more readily adaptable to other language demands/tasks/situations. For example, during classroom implementation #8 (4/13/16), Mr. Mills provided his students with sentence starters to scaffold the predictions they were writing (Figure 4.8).


Predictions:
I think that the gummy bear will…..
I predict that…..

What do you think will happen to the gummy bear in cup #1 (water)?

_____

_____

What do you think will happen to the gummy bear in cup #2 (salt water)?

_____

_____

What do you think will happen to the gummy bear in cup #3 (vinegar)?

_____

_____

Figure 4.8. Actual sentence starters provided to 5th grade Language Academy students by Mr. Mills to support their predictions.

The second sentence starter, "I predict that…" would be a sentence starter that students could apply to any predictions that they would make. When introducing these sentences, Mr. Mills briefly presented them to the students before they started their experiment, "I want you to make a prediction for each gummy bear. And there's a sentence starter right there to help you out to get you started, okay?" (Classroom

Implementation #8, 4/13/17). This sentence starter was less specific because it did not include vocabulary that was specific to the experiment the students were completing. However, without a larger discussion about how to use this sentence starter to make predictions it would be incumbent on the students to make a connection between this scaffold and future predictions they would make.

There was one instance that stood in contrast to this use of the scaffolds to target specific, discrete language tasks, in which Mr. Mills began to move toward using the scaffolds to have a larger conversation about language with his students. In this instance, Mr. Mills had a conversation with his students that focused on language in ways that the students could apply more broadly, to language tasks beyond answering a specific prompt in the lesson. During the opening lesson of the wind turbines unit, classroom implementation #12 (5/9/16), Mr. Mills provided his students with sentence starters to support their predictions. However, in this case when providing these sentence starters to his students, Mr. Mills provided some instruction to his students that was aimed at supporting their understanding of what predictions were and how to make them (Extract 10).

Extract 13 – Classroom Implementation #12 – 5/9/16 (01:30-04:30)

1	Mr. Mills	What is going to happen when I turn on the fan? Don't say it out loud. Now put your
2		hands down, we'll get to it, but I want to go through a couple things first. Okay so,
3		how do we make a prediction? So the first question is, first what is a prediction?
4		Raise your hand if you know what a prediction is, what is a prediction? Why don't
5		you check with your neighbor first real quick, go. ((students turn and talk)). Okay
6		turn back to me. somebody share with me what a prediction is, not your prediction
7		for this but just in general, what is a prediction? If only I had more than two people
8		raising their hand that would be awesome. Excellent, Emma what is a prediction?
9	Emma	What you think is going to happen.
10	Mr. Mills	What you think is going to happen. Does a prediction always have to be correct?
11	Students	No
12	Mr. Mills	Is it okay if it's wrong?
13	Students	Yes
14	Mr. Mills	Do you get to go back and change your answers if your prediction was wrong?
15	Students	((mix of yes and no))

16	Mr. Mills	Then you'd be one of those people, you'd be a prediction changer. You don't want to
17		be a prediction changer. So now I have a sentence here to help you, that's been kind
18		of the theme of our class, is me giving you sentence starters to help [you], so I want
19		you to predict for me what you think will happen when I turn on fan but I want you
20		to say, ((reading off board)) "I think that blank because blank" or "I predict blank."
21		Okay so predict now, what you think will happen. Turn to your neighbor and make
22		that prediction for me.

As can be seen in this extract, Mr. Mills started this lesson by discussing with his students what predictions were before moving into providing them with the sentence starters. He did this by asking the students "what is a prediction" (Line 3) and allowed the students time to turn and talk with a partner (Line 5) before having a student share her idea of what was a prediction (Line 9). Mr. Mills then discussed with the students how predictions can be wrong, and that this was okay, but that the students did not get to go back and change their predictions if they were wrong (Lines 13-19). At this point, Mr. Mills introduced the sentence starters to the students to help them understand how they should make their predictions (Lines 20-23).

In this example, by leading the students through the discussion of what are predictions and how do students make them, followed by the sentence starters, Mr. Mills connected his scaffolds to the broader science language function of making predictions, and provided his students with a language scaffold that the students could draw on in a different situation to produce similar language. The scaffolds provided here were not specific to a discrete language task, and by having the discussion with the students around predictions and how to make them, the students might be able to draw on the learning that happened in this lesson to make predictions the next time they were asked in class.

The focus on scaffolding specific and discrete language, as opposed to scaffolding broader, more general language, aligned with Mr. Mills' goals for our work together during the teaching experiment. As discussed above in Mr. Mills' planning processes, his goal for this work was for language scaffolding and instruction to become a small component of his teaching, and he was very adamant about keeping the focus of his lessons on the science content he was responsible for teaching. The ways in which he implemented the scaffolds in his classroom reflected this goal, with the focus of every lesson being on the science content and activities the students were engaging with, while the language scaffolds were simply there to support the students in constructing their oral and written communication about the science content.

Mr. Mills implemented a number of scaffolds for science academic language, including all of the scaffolds he planned through the coaching conversations, as well as scaffolds that were not planned and provided to students in the moment to scaffold their science academic language. These scaffolds were used to scaffold very specific and discrete language, and Mr. Mills' expectations for the use of the scaffolds by the students evolved as he progressed through the classroom teaching experiment. Overall, the findings have described and examined how Mr. Mills engaged in the process of planning and implementing scaffolds for science academic language, and illuminated how the instructional coaching partnership assisted in that process. The following chapter, Chapter 5, extends these findings, presenting conclusions, challenges, implications, and limitations of this work, after which directions for future research are discussed.

Chapter 5: Discussion, Conclusions, Implications, and Future Research

The goal of this study was to examine the ways in which an elementary science teacher planned for and implemented scaffolds for science academic language while engaging in a coaching partnership, as well as to understand the resources that assisted the teacher in this work. This study therefore examined the teacher's actions and processes while planning and implementing scaffolds for science academic language while engaging the coaching partnership that took place during the classroom teaching experiment. In this final chapter, I first extend and discuss the salient findings that were presented in Chapter 4, as well as address the challenges that emerged through the analysis of the classroom teaching experiment and coaching partnership. I then present implications of this work with respect to teachers and teacher educators who engage in partnership work. Finally, I discuss the limitations of the study and future research directions related to scaffolding science academic language and supporting teachers in this work through partnership approaches.

Conclusions

This study was guided by three research questions that sought to understand how an elementary science teacher engaged in planning and implementing scaffolds for science academic language while participating in an instructional coaching partnership. The following section addresses the salient findings for each question by extending and discussing the results of the analysis. These three questions included:

1) What actions and processes does an elementary science teacher engage in while planning instruction that scaffolds science academic language?

a) What resources assisted the teacher in planning scaffolds for science academic language?

2) What actions and processes does an elementary science teacher engage in while implementing instruction that scaffolds science academic language?

These questions focused on three important components related to scaffolding academic language and the role that an instructional coaching partnership can play in the scaffolding, namely planning, implementation, and resources utilized. I discuss these three components based on the findings of this study and their implications to science teaching and learning.

Planning. As described in Chapter 4, while participating in the coaching partnership, Mr. Mills planned a number of scaffolds to support his students in both vocabulary use and development, as well as in understanding how to structure the responses they were expected to produce. The scaffolds that Mr. Mills planned for early in the teaching experiment were focused more on vocabulary, which was unsurprising as vocabulary is a common focus for elementary teachers (Fisher & Frey, 2010) and particularly for science teachers due to the high number of content specific terms found in science lessons (Snow, 2010). As the classroom teaching experiment progressed, the scaffolds that Mr. Mills planned shifted in focus to helping students understand how to structure responses to the prompts and questions they were asked, primarily through the use of sentence starters. This shift was encouraging because the language students needed to use in the science classroom entailed more than simply the science vocabulary terms. Studies show that students who understand the language structures and forms that are intrinsic to school and science classrooms tend to do perform better academically in

science (Dutro & Moran, 2003; NRC, 2012). Similarly, early, and regular, planning and use of sentence starters as scaffolds in science lessons could aid students in utilizing academic language in various authentic contexts (Hill & Flynn, 2006) such as across different science content areas or practices.

When planning these scaffolds to provide to his students, it was common for Mr. Mills to need to first clearly articulate what he wanted his students to say or write, and how he wanted his students to use language during his lessons prior to planning scaffolds to support that language. By doing this, Mr. Mills generated scaffolds that directly targeted the language he articulated, and the types of responses his students would be generating in his lessons. The findings of this study suggest that teachers need to make their expectations for language use clear to their students (Schleppegrell, 2004) and in order to do so they must first make those expectations clear to themselves (Fillmore & Snow, 2002). Mr. Mills' articulation of his expectations for student responses allowed him to provide scaffolds to his students that helped them understand the structures and forms that he was expecting them to use when responding to science prompts and/or questions.

As Mr. Mills and I engaged in the coaching meetings to plan scaffolds, Mr. Mills also used this time to reflect on his students, academic language, and the scaffolds we were generating and providing to support his students. When reflecting on academic language, Mr. Mills shared his frustrations with supporting language in his classroom, and the challenge in finding the right balance between science content and language. During his discussion of academic language, Mr. Mills was very focused on the science content that his students needed to learn, and felt that at times teachers could spend too

much time focusing on language, or focus on too narrow or high level of skills with elementary students. This tension largely stemmed from how little science instruction his students received relative to other subjects and that he did not want to be forced to take time away from the science content to focus on teaching language. His actions, and the focus he placed on the content is consistent with the findings of other researchers, who have found that even language teachers have struggled to balance content and language instruction and will prioritize content instruction over language instruction (Baecher et al., 2014; Bigelow, 2010; Cammarata & Tedick, 2012).

One of the most encouraging findings from the analysis of Mr. Mills' planning was his application of the scaffolds for science academic language to new settings and situations. During the coaching conversations, Mr. Mills described how he was applying the work we were doing in the teaching experiment to other aspects of his teaching. Mr. Mills shared how he had added sentence starters in his science lesson plans for other grade levels that he taught, as well as how he was encouraging the student teachers that worked with students in his room to think about the language their students would need. I believe that this application to new situations is evidence of the value that Mr. Mills saw in the scaffolds he was providing to his students, and of the learning that occurred for Mr. Mills through his engagement in the classroom teaching experiment and coaching partnership.

When examining the resources that supported Mr. Mills in planning and implementing scaffolds for science academic language, the coaching partnership and the actions I took as a coach were the main resource that facilitated Mr. Mills' planning and implementation. The primary way that the coaching partnership assisted Mr. Mills was

through the utilization of Knight's (2007/2009) partnership principles to create opportunities for Mr. Mills to plan and implement scaffolds for science academic language. Specifically, the partnership principles of *voice*, *dialogue*, *reciprocity* and *reflection* were utilized to support Mr. Mills in articulating his expectations for student language use and in thinking generally about academic language as well as the scaffolds he was planning and implementing. The partnership principles of *equality*, *praxis*, *reflection* and *reciprocity* were associated with one learning experience that was influential in Mr. Mills' planning and implementing of scaffolds. These principles were adhered to when I inserted myself into one of his lessons and modeled the use of sentence starters, after which point Mr. Mills took up the scaffolding strategy of sentence starters and implemented them throughout the remainder of the classroom teaching experiment. Coaching partnerships require strong partnerships to allow such modeling to occur (Knight, 2007) and by maintaining and honoring the partnership principles the coaching partnership allowed for the sustained time to focus on learning and developing new instructional strategies that teachers need when adopting new practices (Brand & Moore, 2011; York-Barr et al., 2006).

Implementation. Mr. Mills implemented scaffolds for science academic language in 13 of the 17 classroom implementations that were observed as a part of the teaching experiment. These scaffolds were a combination of designed-in scaffolds that were planned prior to the lessons, as well as point-of-need scaffolds that supported student language use in the moment. Mr. Mills also implemented every scaffold that was planned through the coaching conversations, and implemented those scaffolds exactly as he had planned them. In addition to the planned scaffolds, Mr. Mills also implemented strategies

that provided point-of-need scaffolding for his students, including rephrasing and restating student responses or providing unplanned sentence starters.

As Mr. Mills implemented sentence starters to scaffold his students' language, his expectations for how the students should use the sentence starters evolved as he progressed through the teaching experiment. Early in the teaching experiment Mr. Mills presented the sentence starters as options, however as he continued implementing sentence starters his practice evolved to instead require all his students to use the structure provided by the sentence starters. This evolution in how he used the sentence starters was in line with studies that show incremental change in teachers' instruction as they learn new instructional practices (Arora, Kean, & Anthony, 2000). Furthermore, teachers tend to alter their practice when they have the opportunity to learn, practice, implement, observe and reflect on their practice (Speck, 2002). The classroom teaching experiment and the coaching partnership provided a space for Mr. Mills to engage in an iterative process of planning, implementation and reflection on the usage and value of sentence starters in science teaching and learning, which led to the evolution in how he used those sentence starters.

The other salient finding from the examination of Mr. Mills' implementation was his use of scaffolds to support his students with very specific and discrete language tasks, such as describing which "bird beak" worked the best to pick up a specific food source during the adaptations unit. The scaffolds that Mr. Mills implemented were used to scaffold his students in producing a specific response to a specific prompt in all but one instance. These scaffolds were primarily in the form of sentence starters and provided the students the structure they would need to begin their response. By using sentence starters,

Mr. Mills provided his students with guidance on the type of responses he was expecting, and provided them with the necessary grammar, structure and vocabulary to produce those responses. This was encouraging as teachers often struggle to make their expectations clear to their students (Schleppegrell, 2012), and it is important that students are supported in using the language forms found in school (Dutro & Moran, 2003).

While it was encouraging to see Mr. Mills support his students in using specific language structures, there needs to be caution in implementing scaffolds that support such specific and discrete language tasks. The goal of providing scaffolds is to help students in learning how to use certain language with the aim of removing the scaffold as students gain mastery in using that language (Bunch et al., 2015; Gibbons, 2003; Jantien Smit, Van Eerde, & Bakker, 2013). Students need have experiences that allow them to learn common language forms that can be applied broadly across language tasks and subject areas (Dutro & Moran, 2003; Fisher & Frey, 2010). The scaffolds that Mr. Mills provided his students, with the exception of the one instance discussed in Chapter 4 (in which Mr. Mills supported his students in understanding how to make predictions), focused on such specific language that is difficult to say how the students would be able to apply those scaffolds to future language tasks. A scaffold such as "The cactus has _____ to help it _____." (Classroom Implementation #5, 3/23/16) is not a scaffold that students will be likely to apply in other lessons or to other language tasks because of its specificity.

Mr. Mills' use of scaffolds to support very specific language with his students was not necessarily surprising when considering Mr. Mills' goals for our work together in the classroom teaching experiment and coaching partnership, and his perspectives on the balance between science content and language. Mr. Mills voiced concern about

maintaining a focus on the science content and not spending too much time on the language and literacy skills his students needed. As he said, “I'm teaching science, I'm teaching a science lesson, so I want to do that.” (Coaching Conversation #12, 4/20/16), and the scaffolds he planned and implemented mirrored this sentiment. They focused on producing meaning around the content and did not take time away from the lesson to teach language skills or structures.

Challenges. Through the analysis of the resources that assisted Mr. Mills, and the examination of my reflection notes and the coaching partnership, a theme emerged that dealt with the challenges and tensions that I encountered as a coach. Even with the strong existing partnership that spanned multiple school years by the time of this study, the work we did together was not completely seamless, and we were not successful in all our efforts to scaffold science academic language. Because Mr. Mills and I never explicitly discussed trends that emerged around these challenges, I will present this theme here as a part of the discussion and conclusions as this allowed me to speculate about why these challenges emerged during the coaching partnership.

While the coaching partnership supported Mr. Mills in planning and implementing scaffolds for science academic language, and in promoting his thinking and understanding around academic language, this partnership was by no means without its challenges. There were a number of challenges that Mr. Mills and I faced during our work together in the coaching partnership, and were the result of different factors. These challenges included both challenges inherent in the coaching partnership, as well as my actions as a coach. Two specific challenges were most prevalent during the coaching partnership: 1) Difficulty maintaining a focus on student language during the coaching

conversations, and 2) Struggles to plan scaffolds that were different than sentence starters to support science academic language. Each of these challenges will be discussed in detail in the sections below.

Difficulty maintaining a focus on student language. The first challenge that Mr. Mills and I experienced in our coaching partnership was difficulty at times to maintain a focus on student language and the academic language the students would be using during the lessons. The aim and goal of the coaching partnership was to support Mr. Mills in examining the language his students would be using and in identifying scaffolds that would support their learning and use of that language. However, while much of our conversation focused on this goal, this was not always the case. Every conversation that Mr. Mills and I had involved talk that was not focused on identifying the language that his students would be required to use.

The nature of the talk that was not focused on planning for language varied. At times during the coaching conversations, our discussions focused on preparing lessons he would be teaching, and how those would play out in the classroom. This is not to say that Mr. Mills did not know what he was going to teach, but that in order for he and I to discuss the language his students would be using, we first needed to have a common understanding of what would be occurring within the lesson. In other instances, we did not focus on planning language supports because our conversation focused on determining what would be taught over the next few lessons, and focused our conversation on the science topics that would be covered. There were also instances where our conversation simply shifted to topics that were not related to our professional work together. During our work together in the classroom teaching experiment, Mr. Mills

was in the process of buying a house which he frequently talked about as well as just other seemingly random topics that were discussed at various points in our conversations.

While it is certainly unreasonable to expect that our coaching conversations were always on the topic of science academic language and identifying scaffolds that could be provided to his students, the conversations that were not focused on language took time away from conversations we could have been having around language. I felt challenged by these conversations, voicing my frustration in my reflective journal, feeling on days that included more off topic conversation that the day "wasn't a terribly productive day" (Reflective Journal, 4/11/16) and that "we didn't do any real planning for anything" (Reflective Journal, 5/18/16).

Difficulty providing coaching that supported Mr. Mills in planning scaffolds that were different than sentence starters to support science academic language. The second challenge that emerged during the coaching partnership was a struggle to plan scaffolds that were not sentence starters, and my inability to provide coaching for Mr. Mills to him move beyond these as a strategy to scaffold student language. As Mr. Mills and I progressed into the later stages of our work together, I aimed to help him identify and plan different types of scaffolds that he could use with his students, to support broader language understanding and use in his classroom. I hoped to help Mr. Mills develop a range of scaffolding strategies that could be used in a variety of contexts and situations. Specifically, I hoped to support Mr. Mills in planning instruction that would include some discussion with his students about the types of language that they would be using and how the scaffolds would support that use. However, as was described in the findings for research questions 1 and 2, Mr. Mills primarily planned and implemented

sentence starters with his students. Zwiers (2014) notes that there can be a danger in relying too heavily on sentence starters to scaffold student language, with the possibility of "linguistic enabling" occurring when sentence starters provide too much support and students are not required to think to complete their response. Through my entries in the reflective journal that I kept, this was something that I noted I was concerned about, and was a part of why I hoped to move him toward other strategies:

> I think it would be useful if we could look at [some different scaffolds] and maybe try to help him [Mr. Mills] move away from just relying so heavily on sentence stems. I worry about linguistic enabling and that we're relying a little too heavily on those. (Reflective Journal, 4/13/16)
>
> Maybe too reliant on them [sentence starters]. [He was] getting too many of the same responses [from the students]. (Reflective Journal, 4/18/16)
>
> I'd like to see if I can push him to maybe try to think of some different way we could support it. (Reflective Journal, 5/9/16)

A possible explanation for why I struggled to provide coaching to Mr. Mills that supported him in scaffolding language with other strategies is illuminated when we examine Mr. Mills' interaction with the Dutro and Moran (2003) framework.

The aim of any instructional coaching partnership is to support teachers in developing both their practice and knowledge (Knight, 2007). Therefore, this instructional coaching partnership aimed to support Mr. Mills in both his knowledge of academic language, as well as his skill development around scaffolding science academic language. One of the actions I took to support this aim was to provide him with the Dutro and Moran (2003) framework *Rethinking English Language Instruction: An Architectural*

Approach, which was described in detail in Chapter 1. This framework was provided and discussed during the coaching conversations with the goal of increasing his understanding of academic language and its components. I provided Mr. Mills with a copy this framework, which he read, and we then discussed the framework during coaching conversation #12 (4/20/16). This conversation around the framework led to an extended, rich conversation in which we focused on academic language, its use in the classroom, and how to support academic language use in his classroom.

Drawing from Mr. Mills' comments during this conversation, we can begin to parse out why Mr. Mills was drawn to sentence starters, and why as a coach I struggled to provide coaching that moved him away from sentence starters as a scaffold. Mr. Mills was adamant about his role as a science teacher and that he was responsible for teaching the science content. During this conversation he noted, "I'm teaching science, I'm teaching a science lesson, so I want to do that." He was also very firm in his thinking that, at times teachers can try to do too much with language, in ways that they lose the focus on content and "force this high-level crap" on the students. Mr. Mills also stated that he simply wanted "[his students] to tell [him] what they did to begin with." When accounting for Mr. Mills' perspectives, one can reason that he focused on using sentence starters to scaffold science academic language because sentence starters allowed him to foreground the science and not focus much instructional time on language. Research has shown that instructional time for science in elementary classrooms has been reduced over the last 15 years (Blank, 2012), and with only seeing his students for 50 minutes, two times a week, Mr. Mills was hesitant to spend too much time focused on language at the expense of content learning. Therefore, the sentence starters in many ways provided an

ideal scaffold for Mr. Mills to plan and implement, as the sentence starters provided his students with enough scaffolding that they were able to communicate their thinking and understanding of the science content being taught without requiring significant instructional time.

This challenge highlights a tension that exist within any instructional coaching partnership; the tension between the coach's perspectives of what could/should be done in the classroom, and honoring and maintaining the partnership principles on which that relationship is built. This tension was something I felt very strongly with Mr. Mills, and in my attempts to provide coaching that moved him to provide scaffolds other than sentence starters.

Implications

This study has multiple implications for both elementary teachers interested in scaffolding science academic language, as well as for teacher educators who are interested in engaging in partnership work with elementary science teachers to support science academic language use and development. The following sections will describe the implications for teachers and teacher educators that emerged through the analysis of Mr. Mills and my experiences during the classroom teaching experiment.

Highlighting connections between science and language. It is important that students receive instruction and support into learning how to access the academic language they will need to use in school and science classrooms. For many of our students, this language is different than the language they use in everyday conversation and it is unlikely that students will simply learn academic language by hearing it in the classroom. However, I also share Mr. Mills' concerns about taking time away from

science instruction to focus on academic language and literacy skills. I recall my own frustrations as a second grade teacher with having, at most, 45 minutes twice a week for science, while my schedule included two hours every day that was dedicated to literacy instruction, and two hours every day for math instruction. It is important that teachers are not taking time away from engaging their students in meaningful science exploration and instruction, but finding ways to integrate academic language and literacy instruction into their science.

Fortunately, science and language are inextricably linked (Lemke, 1990), and science provides a rich and meaningful context for students to engage in authentic language learning while participating in activities, investigations and experiments. Teaching students how to read, write and talk in the ways that science requires is teaching science, and will support deeper content learning. One way this could occur is through focusing science academic language instruction around the science and engineering practices (NGSS Lead States, 2013), and their associated language functions, such as making observations, making predictions, describing, explaining, or stating a claim and supporting it with evidence. Mr. Mills' discussion of predictions with his students during the wind turbines unit (described in the analysis of research question 2), provided a glimpse of how this might occur. Elementary teachers could include components of their lessons that discuss the specific science or engineering practice being used, such as making predictions, and the language forms, structures, and vocabulary that students might need to engage with that science language. This conversation could then serve as a reference point the next time the students and teacher return to this practice, allowing the students to apply that learning and scaffolding to new lessons and activities. Teacher

educators can support the teachers they work with in understanding the connections between science and language by highlighting how there are specific language forms and structures that teachers and students use in science to accomplish the science and engineering practices found in *A Framework for K-12 Science Education* and NGSS, and that those forms and structures may not be consistent with the language resources their students bring to the classroom.

Coaching partnerships for scaffolding science academic language. The coaching partnership presented both benefits and challenges for myself and Mr. Mills and raises three implications for teachers and teacher educators interested in engaging in partnership work. First, engaging in an instructional coaching partnership, and maintaining Knight's (2007) partnership principles, while focusing on scaffolding science academic language was shown to be a means for supporting an elementary teacher in developing his skills and knowledge around academic language. The partnership allowed Mr. Mills to plan and implement a number of scaffolds for science academic language and provided him with the space to think about, discuss and grapple with how to best scaffold language in his classroom and the balance between science content and language learning. This is not to say that a coaching partnership is the best means to support teachers in this work, as Mr. Mills and I experienced a number of challenges in our year-long coaching partnership, such as struggles to maintain a focus on language in our conversations and struggles with identifying more than one type of scaffold.

Secondly, the coaching partnership as it was constituted in this study may not be possible for every teacher or teacher educator. This classroom teaching experiment and coaching partnership required a tremendous amount of both Mr. Mills' and my time, with

us working together for approximately three hours, twice a week. Work of this nature requires both the coach and teacher have the space to dedicate regular time to the coaching meetings, an administrator who is supportive of the work, and a teacher who will open their classroom to a teacher educator and who wants to engage in this type of partnership. Without Mr. Mills' desire and willingness to engage in the partnership, and the support of his adminstrator to allow us to use his preparation period for the coaching conversations, this work would not have been possible.

Finally, the nature of the coaching partnership raises questions about the scalability of this work. While it was feasible for me as a doctoral student to engage in this intense partnership with one teacher, and produced a significant localized impact in Mr. Mills' classroom, it would not have been feasible to perform the same level of coaching with multiple teachers. If our hope is to impact the instruction of a larger audience of elementary science teachers, other models will have to be developed to support teachers in this work. There are numerous possibilities that could be pursued to impact a higher number of teachers and classrooms, some of which include: group coaching and professional learning communities, peer coaching, professional development workshops, working with grade level teams, or leveraging work with professional development schools.

Limitations

As with all research, there are limitations to how the findings can be used an applied. For this study, there are two limitations that limit the scope of the findings.

Generalizability. The first limitation of this study is that it is limited in its ability to provide generalizable findings that can be applied broadly across elementary science

classrooms. This study was focused on one teacher, at one elementary school, working with one group of students that came to his room. Cobb (2000) notes that the aim of a classroom teaching experiment is not to produce generalizable information but instead to develop a theoretical analysis from examining one case that can be used to support the interpretation of other cases. Therefore, the aim of this study was not to develop broad, generalizable findings about how elementary teachers should scaffold language, but instead to understand how one elementary science teacher engaged in the process of planning and implement scaffolds and the role that an instructional coaching partnership played in that process.

No student data. The second limitation pertains to the analysis of the scaffolds that Mr. Mills provided to the students. Because this study was focused on understanding Mr. Mills' actions and process when planning and implementing, and the role that the coaching played in those actions and processes, I did not collect data on the students' interactions with the scaffolds. This study does not speak to the effectiveness of the scaffolds that were provided to the students, and is not able to determine if they influenced student learning.

Future Research

The findings from this study, as well as the limitations discussed above, have led to the development of a number of future research directions that will extend this work. The primary research direction that I am interested in pursuing is scaling up this research to create a broader and more complete understanding of how teachers engage in planning and implementing scaffolds for science academic language. If this scaling up is to occur, it will require a different partnership model and methodology, and would likely include

the use of professional development workshops and professional learning communities or group coaching. However, even with this difference, this study would provide further understanding of the ways in which teachers develop scaffolds to be used with their students, the types of language that teachers choose to focus on with their scaffolds, and how teachers implement scaffolds with their students to support science academic language use and development in classrooms. I hope to use this scaling up as a space to also extend the current research study to the students to understand their engagement with the scaffolds during instruction. By including students in future research, I hope to understand how students choose to interact with and use scaffolds, which types of scaffolds are effective or not in supporting student language use, and to how the use of scaffolds affects student language use both when the scaffolds are provided and when they are not.

Another area of future research that I am interested in pursuing is a comparison of scaffolding science academic language between elementary science teachers and general elementary teachers. General elementary teachers, who are required to teach all subjects (including science), may engage with the planning and implementing of scaffolds differently because they are already required to teach literacy and language skills in their classrooms, whereas elementary science teachers, such as Mr. Mills, are focused exclusively on science content and standards in their rooms. It is possible that general elementary teachers would engage in that planning and implementing differently than elementary science teachers because of their requirements to teach other subjects in their classroom beyond science.

Finally, I am interested in exploring the language that students need to complete specific language functions that connect with the science and engineering practices. There are specific ways in science that students are expected to perform language functions such as predicting, observing, describing, explaining, etc., and elementary teachers have specific expectations for their students. My hope is to explore those expectations with the goal of creating a learning progression that describes how elementary students may be expected to use language to perform science language functions. A learning progression like this could support teachers in understanding the type of language their students should be using in a specific grade level, and how they can support their students in both developing that language, as well as in moving onto the language needed as they progress through elementary school.

Closing Remarks

This study sought to understand the actions and processes that an elementary science teacher engaged in while planning and implementing scaffolds for science academic language, as well as what resources assisted that teacher while engaging in an instructional coaching partnership. It sought to expand the knowledge base around how teacher practice and knowledge of supporting academic language could be influenced and developed through professional development. Through engaging in the classroom teaching experiment and coaching partnership, Mr. Mills planned scaffolds for science academic language to be used during his lessons, and implemented those scaffolds with his students to support their language use. The scaffolds were used to support the students' use of language that was specific to the lessons and primarily provided them with the necessary language structures to complete specific language tasks. This study

also illuminated the ways in which the coaching partnership supported Mr. Mills in this work, while also highlighting some of the challenges that were associated with our coaching partnership. The findings from this study provide the groundwork for the future research described above, as well as other research directions to further understand how to support students in reading, writing, and speaking during science lessons as they build their understanding of science concepts.

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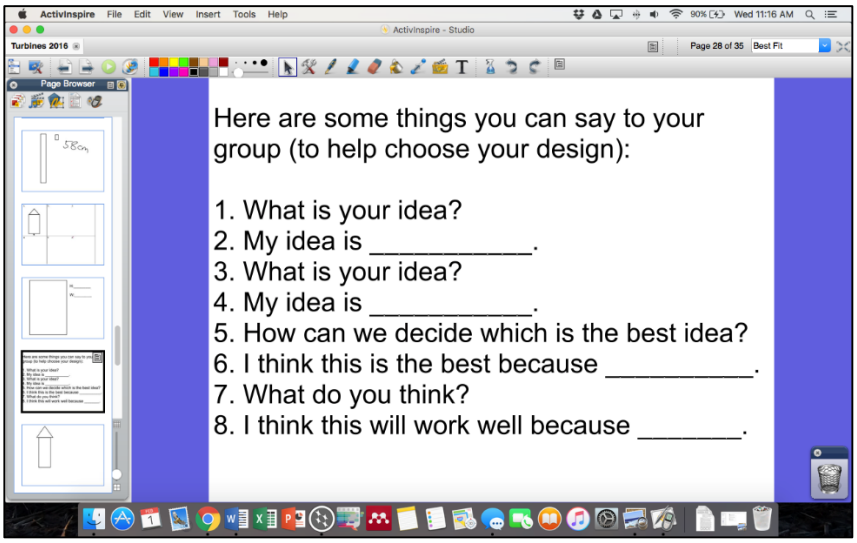
APPENDIX A: Example of Iterative Process of Classroom Teaching Experiment

During coaching conversation #17, Mr. Mills and I were preparing for a design conversation that his students would be having about the wind turbine blades they were designing. As we were discussing we had the following conversation where I introduced the idea of supporting those design conversations and we decided to create sentence starters to support those conversations.

Coaching Conversation #17 (5/16/16)

80	Coach:	So we could give them maybe so one of the things that we talked a little bit about last
81		time will be sought of how we like facilitate them having the conversation at the
82		table like so like shifting what we've had them use. So it could be like so I have this
83		resource it's in the our folder about academic conversations and its constructive
84		conversation skills poster and, where is it, it's this one, convo skills. And so it could
85		be like we could have them like maybe some of these like -- so we could give them
86		some of the sentence stems like I think one idea I have is like and they tell them like
87		you would describe like I think we could put some of those things like get them
88		sharing some of their ideas like I think should look like this. Or something like that.
89	Mr. Mills:	Should we have this printed out for them or how can we do?
90	Coach:	I don't think that this like --
91	Mr. Mills:	No I'm not saying this is a poster but like type up some of the ones that we use in a
92		handout or something
93	Coach:	In a handout or even we just like reference them like so like we say we do this and
94		then here are some things you could say like
95	Mr. Mills:	Your group, right?
96	Coach:	Yeah, say to your group to share your idea right and we don't have to write to share
97		our ideas but
98	Mr. Mills:	Okay, one give me something, we'll do it, lets how about this, let's find some.
99	Coach:	Let me open it actually, like I think it'll.
100	Mr. Mills:	Cause we can always leave those sentences up as a reference.
101	Coach:	Yeah so like after you have to explain so like now you going to come back and do?
102		Once they go through and use these sentences together then they would decide on
103		which one they want to do and draw in that one that you just made up right and then
104		yeah throw the sentences backup and just leave them there. #00:10:33.02#
105	Mr. Mills:	Here the design we are going to choose is number, blank because, which is kinda the
106		same thing as the other side but, but I want to know why it's better than the others
107		So I'll say why is the.
108	Coach:	But so okay
109	Mr. Mills:	Or you don't want that there because you want them to talk about it.
110	Coach:	No I think that's fine, what I'm confused about is, are they completing six each
111		individually
112	Mr. Mills:	That's what we said yeah.
113	Coach:	So then they are going to have different numbers. They might pick number three of
114		off so and so's sheet right? So I mean but if this the same thing as what's on the
115		front then maybe that's just
116	Mr. Mills:	Yeah that's fine.
117	Coach:	So maybe they came up with six and then they pick one to share with their group
118	Mr. Mills:	Yeah
119	Coach:	So what are I mean these might be a little high level we have to adjust them let's see.
120	Mr. Mills:	What you got
121	Coach:	um, well so they like
122	Mr. Mills:	how can we decide which is the best idea

Coach: How can we decide which is the best um or I think this one is the best because, um,
there is like, my idea they could ask like what is your idea? Or my idea is would be
the way they will respond to that. A point of disagreement that I have is --
Mr. Mills: Currently my brain is experiencing a difference of opinion with you.
Coach: I think the negative of blanks outweigh the positives of
Mr. Mills: Nobody talks like that
Coach: I know some of this are a little silly
Mr. Mills: Explain yourself, explain your thinking more, explain.
Coach: Let's see, fortifying support, like I said these aren't all perfect why is that like --
Mr. Mills: Can you give an example from your life? Yes the last time I was creating a turbine
blade --
Coach: When I did this before it all boils down too.
Mr. Mills: How about what do you think?
Coach: Mm hmm
Mr. Mills: I like that. A little too big, maybe not here we go, perfect.
Coach: So those -- right.
Mr. Mills: Say to your group to help choose your design.
Coach: This is a question though right?
Mr. Mills: How can we decide which is the best idea? I'm just saying how can we decide
which is the best idea. I don't know how you can say that without making it a
question because it has the word 'HOW'
Coach: Yeah
Mr. Mills: Change your voice make it sound. It's my mind Cool.
Coach: Or even you can add maybe another one I think this will work.
Mr. Mills: yeah.
Coach: Well.
((laughing at Mr. Mills's typing))
Mr. Mills: Can I put that?
Coach: Your design sucks because.
Mr. Mills: Your design sucks because -- I like that.
Coach: Yeah
Mr. Mills: I think the first class will be a good judge of how well they can use because they are
all mostly you know.
Coach: And you say right this are some of the things we want to hear as you having
conversation it shouldn't just be like present but like talk about it. #00:14:57.06#
((teacher comes in to get something from Mr. Mills, conversation about sentence starters ends))



Mr. Mills then implemented those sentence starters with his students, providing them on the Promethean board. When introducing the sentence starters with his students he and I modeled for the students how they could use them to have their conversations. This modeling is included below.

Classroom Implementation #14 (5/16/16, 13:20-16:40)

1	Mr. Mills:	So you go to your table, how many shapes do you draw? ((students shout out six))
2		Six. Then you're going to look at all your shapes and to yourself, in your brain you're
3		going to say, "Which one do I think is the best that I drew?" Okay, understand? So of
4		all six of yours choose the one, it says right down here, "Come up with six, pick your
5		favorite to share with your group." So you're going to pick one to share with your
6		group that you're going to talk to them about to try to get them to choose that one. I'm
7		going to have some sentences on the board like this. That will help you choose and
8		defend your design choices so
9	Karl:	Should we model it?
10	Mr. Mills:	Yeah.
11	Karl:	Here take that. So let's pretend that this is Mr. Mills' [design], and this is what I drew,
12		just pretend this is my picture, right. Or here, actually, so let's say this is my picture. I
13		might be like, so I might say like, ((modeling conversation)) What's your idea Mr.
14		Mills?
15	Mr. Mills:	Well I think that this shape will work well because its really big and its long so I
16		think thats gonna help it catch the air. But, what is your idea?
17	Karl:	Well I drew a circle and I think that my circle is the best because it will, its got nice
18		big area thats gonna catch lots of air. So Mr. Mills, why did you draw all the spikes on
19		the sides?
20	Mr. Mills:	Um…
21	Karl:	Why do you think that will help?
22	Mr. Mills:	Um…I don't, I, their cool. Um, well I thought that maybe it would help it cut through
23		the air better maybe when its spinning around. But how can we decide which is the
24		best idea?
25	((end of modeling))	
26	Karl:	We're gonna have to work together to figure that out.
27	Mr. Mills:	So you see how ((interruption)) so we're gonna like have to choose of the designs
28		that everybody picks from their own. So if you have four people you're gonna have 4
29		designs you're choosing from, understand? And you have to use these questions

((pointing to board)) to choose your design. Then whatever design you choose, you remember how to do this side? But notice that you're only drawing the shape of the turbine blade, not the whole wind turbine, remember? Okay and Karl and I are going to be walking around to make sure that you don't hear people just go my design's the best because I made it and I'm the best. That's what 5th graders say, right? Your justification or your reason should have something to do with how well it's going to catch the air and make electricity, okay? So what I was telling you about last time that we didn't have is that Karl and I have this little tool that we plug into the wires on the turbine and it actually tells us how much electricity you're going to- you're making, not you're going to make, you are making and then the winner, the winning group gets nothing but you just get to know that you won. Which is pretty cool by itself just knowing that you won is a good prize. Um so you think you can have conversations like that about designs after you take a couple minutes to draw six shapes?

The next time that Mr. Mills and I met, for coaching conversation #18, we then reflected on the implementation of these sentence starters and discussed how they could be modified moving forward or applied to other units. This conversation is below.

Karl: Got it. So, you want to see how the students were talking?
Mr. Mills: Yeah. I do.
Karl: Let's see if, its -- they are a little hard to hear but
((watching video of students talking in their group))
Mr. Mills: because the mic is on there and then.
Karl: TJO is like super put off by having to work in this group and have been separated from the boy group.
Mr. Mills: Really?
Karl: So, he just like has been sitting here and doing nothing.
Mr. Mills: Okay.
Karl: I mean doing but just like not really engaging it's something I noticed.
Mr. Mills: Okay. Who am I hearing though? Not from this group
Karl: We're also hearing ((talking about group next to students)) So, what do you think?
Mr. Mills: It's good I hear them using it.
Karl: Yeah.
Mr. Mills: Yeah. I chose this I've most a lot of -- I chose this one because.
Karl: Yep.
Mr. Mills: But that's still a step in the right direction.
Karl: Yeah
Mr. Mills: It's almost like they need a cheat sheet like a little cheat sheet card. Like when defending,
Karl: yeah or they -- to like learn how to ask those like follow up questions. So, like I say they say I think we should choose this one because blah, blah, blah and gave that reason to then, the follow up of like oh so why do you think it will do that or like that.
Mr. Mills: Yeah. There is like -- it's like we have to discuss those different levels. There is the initial like you just said but there is the deeper conversation too.
Karl: So, then they were -- so then they moved on and we gave them that ruler and they were debating about how long and how wide they wanted to make it.
((watching second clip of students))
Karl: So, the reasoning is interesting because she is like I pick 48 cause its almost the same size as like the other one or something like that. But like why, right?
Mr. Mills: Yeah.
Karl: So, it's interesting.

Mr. Mills: What's the problem is that we ask them to justify something when they don't really know.
Karl: There is no -- they don't really we haven't done anything like --Like, yeah why would it be 48 right?
Mr. Mills: Yeah. But we haven't done -- I mean that's the kind of the thing with the unit though is like this isn't like aeronautics' engineering class. So like they're not going to understand.
Karl: Yeah.
Mr. Mills: you know The drag of the blade and the shape I mean they don't -- it's more like it's a design for fun challenge thing.
Karl: Yeah. It's more like going through the design.
Mr. Mills: Exactly.
Karl: But not so much to like.
Mr. Mills: So, I think it would be great if we could like for example doing this stuff with the Andoddin unit would be great because I think we could really work this deeper level stuff in there.
Karl: Yeah.
Mr. Mills: Like I chose this design from my tree removal tool because it will pick up the trees really well, why does it need to pick up the trees really well. Oh because we need to have a low environmental impact when pick up the trees and don't ruin the surface of the planet.
Karl: And or, and how would pick up -- when you say pick up the trees, well how? How will it do that? So, it will be able to grab up and then pull the top up. Right, wherever.
Mr. Mills: It's still good to see them talking the way we asked them to, but it's just -- maybe this unit is just a little tough for them as far as --
Karl: Some of the, yeah, the --
Mr. Mills: The ideas behind what -- oh that's me.
Karl: Yeah. That's you.
Mr. Mills: I've never see myself teach.
Karl: Oh yeah, you never?
Mr. Mills: I mean, hardly ever.
Karl: Well here, this is you teaching.
((watching more of the video clip))
Karl: Yeah. I think -- and this thing is good, that is sort of like processing with them I'm like how did it go and what do we need to work on.
Mr. Mills: Yeah
Karl: but as you moved around yesterday, did you feel like the conversations were?
Mr. Mills: Except for our Karen girls the rest were doing pretty good because at they just don't have the English yet at all.
Karl: And you think that these were -- this was helpful or?
Mr. Mills: I think maybe next time we could put them in sequence though. Almost as like ask this and this.
Karl: Yeah.
Mr. Mills: Because I mean they're kind of out of order.
Karl: They are a little out of order, aren't they?
Mr. Mills: So, it's like what is your idea and then my idea is, what is your idea again. Let's have them follow the script almost.
Karl: Sure.

APPENDIX B: Example of Coaching Conversation

Part of Coaching Conversation #1 (2/17/16)

1	Mr. Mills:	Okay, this is Mr. Mills and Karl. On February 17th at 12:24 in the PM working on
2		Language Acquisition.
3	Karl:	Thanks for doing that.
4	Mr. Mills:	No problem.
5	Karl:	So, designing and building next week, right?
6	Mr. Mills:	Yeah, so let me talk about what happened today.
7	Karl:	Yeah.
8	Mr. Mills:	So, I was noticing that with my first two classes. It was helpful to review the
9		keywords from the first, I mean, like you know it's kind of just bring us up to where
10		we are kind of deal. Renewable, nonrenewable, you know, that we used maps and
11		location, refining, um environmental impact like those, those words and what they
12		meant. Because those are going to come into play, more of the environmental impact
13		when we are building our mining tools. So, we'll review that, and then we get into the
14		engineering design challenge, I think this afternoon, I need to incorporate more of the
15		engineering design process.
16	Karl:	Okay
17	Mr. Mills:	I meant but I want to do a better job. I did it but I want to do better I think from
18		reflecting for my first two classes.
19	Karl:	Okay
20	Mr. Mills:	Um. But I think that's kind of the big language piece
21	Karl:	Okay
22	Mr. Mills:	that engineering is on process and the, the vocabulary if you will from the first part of
23		this or the unit. So, that's where I'm at. #00:02:06.46#
24	Karl:	The other piece I saw it on this page is that you had this that you showed me from this
25		morning, um the construction steps.
26	Mr. Mills:	Yeah
27	Karl:	We could do some
28	Mr. Mills:	like procedural
29	Karl:	Like first then next we could give in those words as well. Like if we wanted to be
30		more like step by step or if it's just a like here's the things you're going to, I don't
31		know.
32	Mr. Mills:	No and I like that but I want to do that next time because they weren't even supposed
33		to do this this time. Yeah this is just they know they have a couple of students that I
34		was working on.
35	Karl:	This was just this group. Oh okay. Yeah, yeah.
36	Mr. Mills:	This was just -- it was supposed to be just the drawing today, just the ideas --
37	Karl:	Because right now it's just they're getting their individual ideas
38	Mr. Mills:	Exactly
39	Karl:	to then come up with a
40	Mr. Mills:	Exactly, so didn't want them to do double work they wouldn't need to. So, I like that
41		though, let me put that in there.
42	Karl:	So, that's something we can work on, we could you know remind them you know, so
43		if your listing, giving us steps, right, what do we need to, how do we do that, right.
44		how do we give procedural.
45	((pause, Mr. Mills typing in document))	
46	Karl:	Where are you writing that, are you
47	Mr. Mills:	In the lesson sequence.
48	Karl:	Okay. #00:03:09.53#
49	((pause while Mr. Mills is typing)) #00:03:31.66#	
50	Mr. Mills:	Are you staying around this afternoon or you're just --?
51	Karl:	Yeah.

52	Mr. Mills:	Oh, you are? Okay, cool.

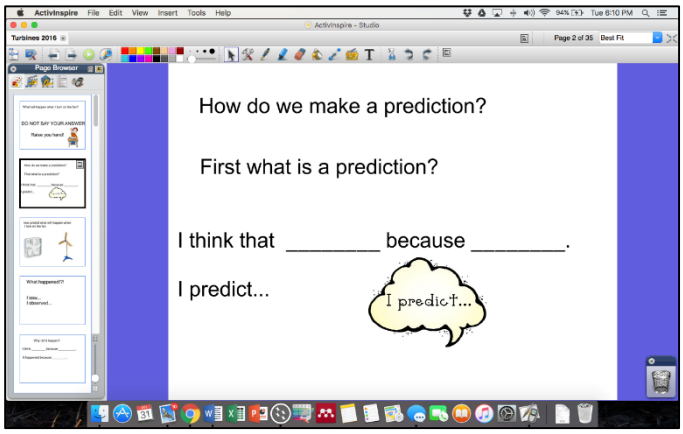
APPENDIX C: Example of Classroom Instruction

Key Episodes of Classroom Implementation #8 (4/13/16)

	2:45 - 5:00	
1	Mr. Mills:	Ashley read that for me.
2	Ashley:	What is a variable?
3	Mr. Mills:	Even if you don't remember what the word means, raise your hand if you remember
4		hearing the variable this year.
5	Student:	We have that in math.
6	Mr. Mills:	Okay now I'm glad you said that now hold on I know because we're farther along in
7		the year now so I know in math its like 4+X=7 and obviously the answer is 12 right?
8		X equals 12. No X equals?
9	Students:	3
10	Mr. Mills:	But that's a variable in math that is not what I'm talking about. We're talking about a
11		science variable. And a variable in science is something else. Does anybody
12		remember what a science variable is? We did, now think I'm gonna give you a little
13		hint, because we did um the experiment where had uh the table and we had the thing
14		had the table
15	Students:	OHHH
16	Mr. Mills:	And we had the string and we did what was the variable in that experiment what did
17		we?
18	Student:	how long the string was
19	Mr. Mills:	Yeah how long the string was, right? And then so what did we do we changed the
20		length of the string. So can I have Yun, wanna read the poster above your head?
21	Student:	no
22	Mr. Mills:	Okay. Callie, wanna read the poster above your head? The top one. Variable
23	Callie:	Something you can change in the experiment that effects the outcome.
24	Mr. Mills:	Something you change in the experiment that effects the outcome. But we're not
25		going to say it with all those fancy science words we're gonna say its something you
26		change in an experiment that changes what happens. So like with that string you made
27		the string shorter what happened, it went faster, you made it longer what happened,
28		slower. Okay. Now so today we're doing gummy bears in different liquids.
	15:15 - 15:30	
1	Mr. Mills:	Now after this, even if you drop your gummy bear in there nothings gonna happen
2		right away, these are gonna sit until Monday, I want you to make a prediction for each
3		gummy bear. And it will tell you there's a sentence starter right there to help you out
4		to get you started, okay. Are we clear on this? Does anybody have any questions.
	30:35 - 31:15	
1	Karl:	Okay so now boys we need to write here, what do you think will happen to the
2		gummy bear that's in cup 1 in water, what do you thinks gonna happen to it when we
3		leave it in here.
4	Student:	((students shares, incomprehensible))
5	Karl:	Its gonna what, I just didn't hear you. Its just gonna stay the same? Okay so write, I
6		think that the gummy bear will stay the same. So here's this, this is the sentence that
7		can help you, I think that or I predict that, and then do the same thing for what you
8		think will happen in the salt water and what will happen in the vinegar.

APPENDIX D: Example of Coaching and Instruction Artifacts

Promethean slide generated during coaching conversation.



Student worksheet with sentence starter generated during coaching conversation.

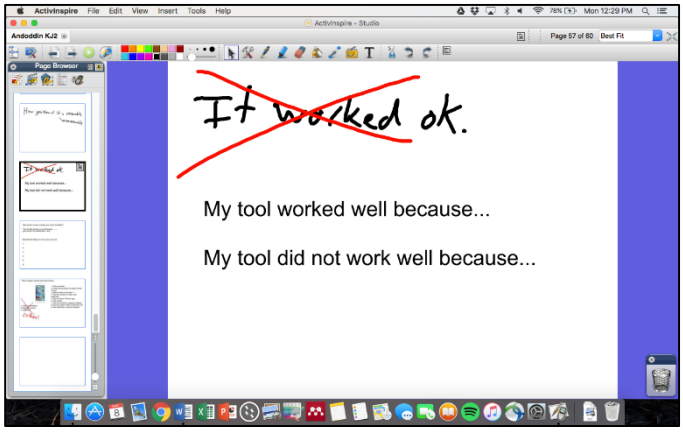
Predictions:
I think that the gummy bear will.....
I predict that.....

What do you think will happen to the gummy bear in cup #1 (water)?

What do you think will happen to the gummy bear in cup #2 (salt water)?

What do you think will happen to the gummy bear in cup #3 (vinegar)?

Promethean slide with mark up from classroom instruction.



APPENDIX E: Example of Reflective Journal

It is May 9, 2016. This is Reflective Journal.Today was pretty good. Mr. Mills and I met to talk about the wind turbines little unit that started today and we were sort of looking at what are we… what was happening in that and we are planning for today for the language academy class. And Mr. Mills very much just like took the lead and just started planning sentence stem loose and those types of things for predictions and then for them to sort of like talk about what they saw and observed when they were observing the activities. So what happened is he showed them a wind turbine and fans set up and said, "What do you think is gonna happen when I turn the fan on? Make a prediction." And then they had to… after making their prediction, he had turned the fan on and he then asked them to share what they observed, what they saw happen, and then beyond that… so like sort of a claim and evidence of like… well, this is what happened and I think… and then giving like a reason for why they thought that happened.

So Mr. Mills started… just jumped right in the planning in some ways that he could support that language. [00:02:00] He wrote some sentence stems, had an I think and an I predict sentence stem and then also had… I can't remember… I think blank because blank, I think is what he had. And then, yeah, just I predict as another way that they could say it. And then he put like I see and I observed on – when they talked about what happened – and then had given them sort of a claims and evidence, kind of that similar I think that blank because blank, that sort of helped to talk through with them.

One of the things that he did, one of the coaching things that I did, was as we were starting to come up with these sentence stems, to try to get in the let's think maybe a little more than just sentence stems. I said, "Yeah, this might be…" And I said something along the lines of like, "You know, this would be a good opportunity to sort of talk with them about what is the prediction. How do we make a prediction? To sort of get them to sort of come up with some of that language.

So we took that and had a little conversation about like what is a prediction and how do we make that. So you got to how predictions or guess, kind of an educated guess you are using which you have in your head. So then say, I guess, it didn't really focus on… he didn't get to what I was hoping he would and like maybe before giving them sentence stems, asks them to like… so how might you say your prediction. Which is where I sort of really want him to go to so that maybe instead of just him always just giving the sentence stems, he could get to a point where the students are co-constructing those or they're just sharing some ideas of how to say it. [00:04:00] Or is creating like a co-constructed word bank that has some other words that they might need to make their prediction.

I did use some turn and talks to get them… giving them that chance to share their predictions and get that opportunity to practice their fluency. I thought he did a nice job but was sort of taking those ideas and using them. The other thing that I shared with him as we were talking was I said, well, I shared to him about how one strategy that he can use to support his students in more academic forums is to rephrase things into when students say something to rephrase into a more sort of academic way of saying it. That totally made sense to him and he's like, "Oh yeah, I can do that."

But then the responses he was getting from his students didn't actually allow for any real rephrasing. But because he had already given sentence stems and frames, they were able to do that. So we'll see. I am interested to see what happens. So this is thesis proposal day. And so I couldn't stay for that second class, the class we're normally focusing on. And so I saw what he did with the class before which we're not videotaping and he was trying but couldn't. So he was going to try to… imagine that. So like, no, she was trying to but weren't getting really in so he said he was going to try to see… like think about who he calls on and if he gets someone who says it right. He'll try to rephrase it. [00:06:00] So I'm interested to see what comes up on that video and happens in this class period as opposed to the class period before.

Overall, pretty happy with how today went. He is really starting to sort of just kind of take the lead on… like okay, so this is what's happening. So here's how I could support it. Very much sentence stem heavy. I'd like to see if I can push him to maybe try to think of some different ways that we could support it. But that's going to require me, I'll need to share something with him.

So I'm going to have to take a look and think about that for Wednesday. See if we can't… maybe create some… if I can't come up with a good something to help them… that he could latch on to in addition to these sentence stems. But these sentence stems are definitely an improvement. There's something that he wasn't doing beforehand and not to this level of focusing in every lesson. Like, okay what am I wanting them to say. So let me support that by giving them something to base her idea off of. What's good is his sentence stems always are… he doesn't just say like… or how do I say this… he doesn't require only filling in the blanks or his blanks in his sentence stems require much more than like a single word answer. That's at least a positive about him with these sentence stems. They still require students to formulate the thought. It just is giving them the sort of skeletal structure to say that. All right, cool.

APPENDIX F: Initial to Focus Codes for Planning

Sorting of Planning Codes to Move from Initial to Focused Codes

Top level code	Focus codes	Initial codes
Planning Actions	Sentence starters and frames	Posting sentence stems on board, Providing multiple options to students, Sentence stem, Sentence stem on worksheet, Sentence stems at tables for students.
	Other scaffolds	Creating clear expectations for students, Clarifying prompts for students, Explicit language teaching, Modeling, Promethean slides, Strong slideshow as tool to support language, Realia, Student worksheet, Generating students worksheet, Supporting academic conversations.
	Vocabulary scaffolds	Clarifying content specific vocabulary with everyday vocabulary, Content specific vocabulary, general academic vocabulary, Reviewing vocabulary, vocabulary, Vocabulary as big language piece.
	Language functions	Claims and evidence, Justifications, Labeling, Language function as focus, Making predictions, Observations, Procedural language, Numbered list.
Planning Processes	Discussion not leading to planned scaffolds	Differentiation, Differentiation of language supports, iPad as resource to support language, Karl offering to co-teach, Lesson planning as a way to support language, Long range planning to help identify language, Purposeful talk to support language, Rephrasing as a strategy, Using EA who speaks same language as students.
	Discussing academic language	Discussing supporting academic language generally, Discussing what academic language is, Mr. Mills challenging Karl's perspective.
	Generation of scaffolds	Building off Mr. Mills' idea, Co-generating scaffold to provide to students, Connecting language to previous learning, Discussing how scaffold will help students, Karl asking Mr. Mills how he wants to support a language activity, Karl offering a suggestion for a scaffold, Karl offering possible direction, Karl providing language focus, Karl sharing resource, Language focus from Karl, Language focus from Mr. Mills, Struggling to think of scaffolds, Mr. Mills connecting back to previous coaching, Mr. Mills generated language support, Mr. Mills generating idea for language support, Mr. Mills generating language focus, Mr. Mills prepared with ideas to support language prior to coaching, Mr. Mills reaction to planned scaffold, Mr. Mills thinking about support for a specific group of students, Using resource.
	Improving practice	Applying learning to other situations, Discussing PD we would lead, Just making me a better teacher, Sharing example from another class, Supporting language in other situations, Thinking ahead to future practice, Mr. Mills feels practice is changing, Mr. Mills sharing how he has supported language in other classes.
	Language expectations	Clarifying activity students will be doing, Discussing students in class, Karl articulating Mr. Mills' expectations, Karl asking for expectations for language use, Karl clarifying Mr. Mills' expectations, Karl stating language expectations, Struggling to articulate what he wants from his students, Mr.

	Mills explaining his expectations for language use, Mr. Mills sharing activity that will require language, Unclear language expectation,
Reflection on scaffolds	Karl asking for reflection, Reflecting on how to support language next time, Reflecting on student use of scaffolds, Revising scaffold based on reflection, Sentence stems leading to conversation, Video coaching to examine language use.
Mr. Mills' perspectives Language important to science	Nobody talks like that, Practical stuff that's what I want, Struggling to know how to support his students, Mr. Mills explaining his needs, Mr. ills sharing connection to a district initiative, Mr. Millls sharing his struggles, Mr. Mills unsure how to scaffold language focus.

APPENDIX G: Codes Identified as Resources

Codes Identified as Pertaining Resources that Assisted Mr. Mills
Karl sharing his struggles
Linguistic enabling
Sentence structure
Specific language teaching
Karl articulating Mr. Mills' expectations
Karl asking for expectations for language use
Karl asking for reflection.
Karl asking Mr. Mills how he wants to support a language activity
Karl clarifying how Mr. Mills wants to use language support
Karl clarifying Mr. Mills' expectations
Karl modeling posting sentence starters
Karl offering a suggestion for a scaffold
Karl offering possible direction
Karl offering to co-teach
Karl providing language focus
Karl reminding students to use sentence starters
Karl sharing resource
Karl stating language expectations
Karl suggests modeling
Language focus from Karl
Modeling academic conversation
Reflecting on how to support language next time
Reflecting on student use of scaffolds
Using resource

APPENDIX H: Episode by Episode Initial Analysis

Unit and Lesson	Timestamp	Overview of episode
Lesson 1 - Mining Tools – Part 1	9:00 – 15:00	Mr. Mills describing to the students how they should be explaining how their redesign did or did not work better. Provides students with a list of words that they could use to help them in writing their responses. Also makes a point of reminding them they are in 5th grade when sharing his expectations. Talks through students making a statement and proving it by referencing back to the pendulum activity they did earlier in the year. Connects it to Claim and Evidence.
Lesson 1 - Mining Tools – Part 1	15:00 – 17:30	I jump in and add possible sentence stems to support the students in writing their claim and evidence. Mr. Mills then adds at the end to remind the students that they use sentence starters all the time and that they don't have to start this way, but certainly can.
Lesson 1 - Mining Tools – Part 1	28:00 – 29:00	Mr. Mills passes out the paper and reminds students to use the sentence stems and to use 5th grade responses. Explains that he wants the students to work together, that it isn't an individual thing. All students writing, but talking about it together.
Lesson 1 - Mining Tools – Part 1	30:35 – 31:15	I shared with student that the sentence stems are on the board after he shares his idea with me.
Lesson 1 - Mining Tools – Part 2	00:00 – 2:00	Mr. Mills has the students share. Examples of students using the sentence stems.
Lesson 2 - Mining Tools	00:00 – 2:41	Clarifying for students the question that he is asking the students. Changed "function" to "work". Shares with students 5th grade expectation for the writing. Posts sentences again for students on the board to help them. Does this in the middle of the lesson, not pre-planned.
Lesson 3 - Mining Tools	15:00 – 15:50	Mr. Mills sharing with the students the worksheet they will be completing to report about their designs and explain why the mining company should select their tool. Reminds students that they should not only write things like, "Because it's awesome."
Lesson 3 - Mining Tools	15:55 – 17:50	Shares with students that they then need to write instructions about how to build their tool. Connects it back to previous activity where they explained how to make a phone call. Another example of Mr. Mills making his expectations clear to his students about what he wants in responses.
Lesson 4 - Mining Tools	17:30 – 17:50	Call and response with students to help learn the science word, "offspring".
Lesson 4 - Mining Tools	18:20 – 19:00	Clarifies for the students what similarities means. "Same" What is similar? What is the same? Clarifies more academic term, "similarities", with the more general term "same".

Lesson 4 - Mining Tools	21:00	Inherited trait. – Doesn't clarify this term. Missed opportunity in supporting academic vocabulary development. Finally defined at 22:30 in the video. Something you get from your parents, makes you look the way you look.
Lesson 4 - Mining Tools	23:40	Has student use more scientific term. Learns how to catch "stuff" -> "prey". "What's the fancy science word?" "Hunt for prey" -> rephrasing into different form.
Lesson 4 - Mining Tools	24:50	Call and response with "offspring" again.
Lesson 4 - Mining Tools	17:00 – 25:30	Explaining to students how to fill out the adaptations sheet. Making expectations clear.
Lesson 4 - Mining Tools	40:40 – end	Has students share some of the animals that they identified inherited traits, similarities, and differences. Re-stating student responses out loud for group to hear. Provides beginning of sentence to student to help them read their idea.
Lesson 5 – Adaptations – Part 1	2:37 – 8:23	Reviews 3rd grade structure/function. Explains how students should be making 5th grade explanations of structures and functions. Does some repetitions. Revoicing of student responses. Look specifically at 6:40, statement of expectations with a sentence starter. 7:35 student gives response and then Mr. Mills helps/redirects student to use the sentence starter to make more complete sentence.
Lesson 5 – Adaptations – Part 1	8:30 – 11:30	Goes back to other student's idea, uses it as an example of more detail in the responses. Connects this now to adaptation and how he wants them to describe structures and functions. Has students repeat after him to get the word "adaptation" correct. Has students read out loud to the class, then re-reads it himself to make sure the students hear it clearly. 10:25 Then goes into what makes a good description of structure and function. **(IMPORTANT)** Name the part, name the job, and why that job needs to happen/why it needs to do that. Provides clear, concrete example that builds off the third grade example to make clear the expectation for 5th grade.
Lesson 5 – Adaptations – Part 1	11:30 – 12:50	Starts explaining the sentence starters and the adaptations sheet. Shows how sentences are both on the board and on a paper at their tables. Reminds students that they can use the sentence starters that are on the board or create their own sentence, but makes sure to emphasize that they need part, job and reason in their sentences. **(REALLY GREAT EXAMPLE OF SENTENCE STARTERS)**
Lesson 5 – Adaptations – Part 2	00:00 – 1:00	Mr. Mills providing support to highest needs students by showing them a real turtle shell and then helping them understand how they can write their sentence.
Lesson 5 – Adaptations – Part 2	3:15 – 3:42	Clarifies what an "organism" is for a group of students. Defines it as a living thing.

Lesson 5 – Adaptations – Part 2	3:50 – 5:00	Supports highest needs group in finishing their sentence about a turtle shell. Helps them learn the content specific work and has them each repeat it after him.
Lesson 5 – Adaptations – Part 2	6:00 – 7:00	Uses another student to translate for him with the highest needs group.
Lesson 5 – Adaptations – Part 2	9:00 – 9:20	Helps students understand they need to add the reason for the job to their description. Again, making expectations clear.
Lesson 5 – Adaptations – Part 3	00:00 – 10:28	Sharing out the writing the students did describing adaptations. Doesn't repost the SS/F or review them but students share using them. Does some clarification on one or two to get more about why the job needs to happen.
Lesson 6 – Adaptations – Part 1	1:50 – 4:00	Reminds how in previous lesson that they discussed how much detail he expected in their descriptions about adaptations. Reviews all slides from the previous lesson.
Lesson 6 – Adaptations – Part 1	4:30 – 6:05	Call and response with word adaptation.
Lesson 6 – Adaptations – Part 2	1:20 – 3:50	Describing how they need to give a reason. Modeling some language here. Then goes into the sentence starters the students can use to help their writing. Clarifies his expectations with the students.
Lesson 6 – Adaptations – Part 3	00:00 – 2:06	Has students share out their ideas, asks them to share the beak that worked best and worst. Shows how he emphasized use of the sentence starters. Also shows how he had some problems with the prompts.
Lesson 7 – Adaptations	42:00	Has students share out. Did not have same full sentence expectation here as other lessons. No real language stuff in here.
Lesson 8 – State Test Review	2:45 – 5:00	Discussion of variables. Connects to math variables and how those are different than science variables.
Lesson 8 – State Test Review	15:15 – 15:30	Shares sheet with students and points out sentence starter for predictions. Very brief.
Lesson 8 – State Test Review	30:40 – 31:15	I talk to group and point out the sentence starters for them.
Lesson 8 – State Test Review	42:20 – End?	Has students share out predictions. References sentence starter before having students share. Students do this. Missed opportunity to rephrase a student response who didn't use SS/F.
Lesson 9 – State Test Review	2:40 – 3:30	Introduces the sheet to the students. Explains now they are doing observations. Does not talk about sentence starters.

Lesson 9 – State Test Review	12:00 – 12:40	Compliments this class on the writing they have been doing during the last two units and then points out the sentence starters. Very brief.
Lesson 9 – State Test Review	28:30 – 33:50	Has students share their writing. Quickly wrote sentence starters on a slide before having them share. References them and points them out for the students. Repeats student response after they share out. Students using the starters.
Lesson 9 – State Test Review	39:20 – 40:00	Forces and doing work. Provides a sentence starter verbally in the moment to support after asking a question about why they know the pitcher is doing work when throwing the ball. Student uses this sentence structure.
Lesson 10 – State Test Review	6:45 – 8:00	Call and response with the word fulcrum.
Lesson 10 – State Test Review	17:20 – 18:15	Asking students to share weight and scale location. Verbally gives them a sentence starter to help them clearly share what he is asking. Students use it.
Lesson 10 – State Test Review	40:55 – 43:40	Has a sentence frame on the bottom of the page for students to fill in. This one was a fill in the blank type sentence frame. Did not reference it when explaining. Has two students share. One student was close, had second student share. Also clarifies what he means by advantage. Some more sentence starters on the bottom of this sheet to help talk about which was easiest and hardest.
Lesson 11 – State Test Review	0:00 – 3:10	Has students turn and talk, gives students multiple chances to share, asks clarifying questions and requires more responses. Not requiring specific structure but prompting larger responses.
Lesson 11 – State Test Review	23:30 – 29:30	Reviewing conductor and insulator vocabulary terms using models.
Lesson 12 – Wind Turbines	1:30 – 7:00	Explicit discussion of language expectations for predictions. Planned for this then implemented what he planned. Prompts Amir to share more with the “because” word.
Lesson 12 – Wind Turbines	8:00 – 11:00	Has students do observations, explains to them what they need to do. Some more language teaching. Then gets down with one of Karen girls to help them with the observations. Then has students share out, reminds of sentence starter.
Lesson 12 – Wind Turbines	11:10 – 16:00	Asks students why the wind turbine did not spin. Has sentence starters for this as well and scaffolds first part for the students. Turn and talk. Reminds to use sentence starters. Does some rephrasing in this lesson to support the students.
Lesson 12 – Wind Turbines	16:55 – 17:43	Call and response on wind turbine.

Lesson 12 – Wind Turbines	19:30 – 20:30	Explains worksheet to the students and points out the sentence starters on the sheet. Calling it the theme of the class in this lesson.
Lesson 12 – Wind Turbines	21:30 – 31:00	Mr. Mills helping one of the groups (I assume the 5 Karen girls) with reading and writing down sentences. Hard to hear, camera did not get turned because I was not there this day.
Lesson 12 – Wind Turbines	33:00 – 34:30	Has students share things they learned. Reminds first student to use complete sentence by prompting with starter.
Lesson 12 – Wind Turbines	35:40 – 42:30	Ask students what they want to control when making a turbine blade. Has sentence starter on the board for the students to use.
Lesson 13 – Wind Turbines	7:20 – 10:50	Goes back to the sentence starter from the end of day and reviews the things they covered at the end of the last class. Emphasizes the sentence starter again.
Lesson 13 – Wind Turbines	12:00 – 13:30	Has students share out the job of a wind turbine blade. Gives them sentence starter for this. I don't think we planned this together.
Lesson 13 – Wind Turbines	14:30 – 15:45	Has a whole sentence on the board for the students to read. Has a couple students read it out loud.
Lesson 13 – Wind Turbines	21:50 – 22:30	Points out sentence starter at the bottom of the worksheet.
Lesson 14 – Wind Turbines	3:35 – 7:40	Same sentence starter again, when I control wind turbine blade… tells students they have to use it when they turn and talk to their classmates. Then does share out.
Lesson 14 – Wind Turbines	13:20 – 15:50	Sentence starters to support design conversations. We modeled these conversations. I initiated this modeling.
Lesson 14 – Wind Turbines	42:50 – 45:00	Mr. Mills debriefing student language use a bit. Something we did not talk about.
Lesson 15 – Wind Turbines		No language scaffolds in this lesson.
Lesson 16 – Wind Turbines		No language scaffolds in this lesson.
Lesson 17 – Wind Turbines	29:30 – 31:20	Introducing the final design sheet. Shares the sentence starters with the students.

APPENDIX I: Initial to Focus Codes for Implementation

Sorting of Implementation Codes to Move from Initial to Focused Codes

Top level code	Focus codes	Initial codes
Implementation Actions	Implementation of 'point of need' scaffolds	Call and response of vocabulary term, Encouraging conversation, Highlighting content vocabulary term, Highlighting vocabulary term, Multiple students provided opportunity to read, Reading out loud for students, Rephrasing student response, Restating student response, Revisits sentence starter from previous lesson, Student reads out loud from board, Student sharing, Unplanned sentence starter, Verbally providing sentence starter, Working with students during turn and talk
	Implementation of planned scaffolds	Planned sentence starter on board, Planned sentence starters on sheet, Planned vocabulary instruction, Planned word bank on board, Sentence starters to support conversation
	Language Functions	Claim and evidence, Explanations, Justifications, Making observations, Making predictions
Implementation Processes	Implementation of scaffolds	Clarifying vocabulary term, Karl suggests modeling, Providing word bank on board, Brief reference to scaffold, Karl modeling posting sentence starters, Karl reminding students to use sentence starters, Not sharing scaffold when introducing sheet, Posting sentence starter on the board, Posting sentence starters during lesson, Providing sentence starters at tables, Referring to sentence starter on board, Referring to sentence starter on worksheet Reminding students to use sentence starters, Sentence starters as options, Mr. Mills modeling using sentence starter
	Interaction with students	Not keeping student language structure, Not requiring specific structure, Not requiring use of scaffold, Requiring the use of scaffold, Student using different sentence structure, Student using structure from sentence starter, Mr. Mills clarifying student response
	Making language expectations clear	Appropriate 5th grade responses, Clarifying 5th grade language expectations, Clarifying level of detail expected, Connecting back to previous activity, Connecting to other language teaching, Expecting complete sentences, Explaining expectations for responses, Explaining language expectations, Explaining sentence starters to students, Modeling academic conversation, Modeling example response, Shared conversation with individual writing
	Teaching Language	Debriefing student language use with students, Explicit language teaching, Language teaching

APPENDIX J: Useful words and phrases in science writing (Adapted from Fulwiler, 2007, p. 158)

Language Function	Sentence Starters
Questions	What would happen if_____? How does [the changed variable] affect [the measured, observed, responding variable]?
Observations	I observed I noticed When _____. After _____.
Contrasts	_____, but _____. _____, whereas _____. However, In contrast, At first, _____. But now, _____.
Sequence of Time, Cause and Effect, Reasoning	First, _____. Next, _____. Then, _____. Finally, _____. If _____, then _____. So, This leads to As a result, Consequently,
Evidence	_____because _____. For example, For instance, The evidence is The data show The data provide evidence that
Reasoning	_____ because _____. I think this because I think this means
Adding Information, Evidence, Reasoning	Also, In addition, Furthermore,
Conclusions	Therefore, I think In conclusion, I think Therefore, In conclusion,

APPENDIX K: Inquiry Prompts in Science to Promote Common Language (Adapted from Anoka-Hennepin School District, 2014)

Language Function	Sentence Starters
Predicting	I predict that _____ because _____.
Observing	I notice that _____. It looks _____. It smells _____. It feels _____. It sounds _____. It reminds me of _____.
Investigable/Testable/Experimental Questions	How does (X) affect (Y)? How does (A) compare to (B)?
Comparing	_____ and _____ are both _____. _____ is _____, and _____ is too. _____ has _____, and _____ does also.
Contrasting	_____ is _____, but _____ is _____. _____ has _____; however, _____ has _____. _____ has _____, whereas _____ doesn't. _____ is _____, yet _____ isn't.
Cause/Effect	_____ happened because _____. If _____, then _____. _____ happened as a result of _____. I think that variable (X) changed the results by _____.
Communicating Skepticism	I'm not sure I agree because _____. Could you explain how your evidence shows _____? What proof do you have that _____? Perhaps we need to try that experiment again to see if we get the same results.