INVESTIGATING THE NATURE OF TEACHERS' VOCABULARY AND SCIENCE TALK DURING SCIENCE INSTRUCTION IN EARLY-ELEMENTARY CLASSROOMS

By

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ABSTRACT

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Oral language and vocabulary development in the early-elementary grades is important for students' overall academic success. Oral language and vocabulary support science learning, and reciprocally, the background knowledge and vocabulary students gain when learning about the natural world supports their reading comprehension. Therefore, oral language and vocabulary development should be an essential focus of instruction for early-elementary students, and as such, current national standards for literacy and science instruction each emphasize oral language development. Given the importance of oral language and vocabulary development for both literacy and science learning, it is critical to understand how teachers support this development in early-elementary science instruction. Most observational studies of vocabulary instruction have taken place within the context of literacy instruction. As little is known about how teachers promote oral language and vocabulary development in science instruction in the early-elementary grades, the present study investigated (1) how teachers use language to promote oral language and vocabulary development during science instruction in the early-elementary grades, (2) whether/how vocabulary talk relates to the language aspects of science talk, and (3) what features of science curriculum materials are related to enhanced vocabulary talk.

To answer these questions, I conducted two instrumental case studies. In the first study, I examined the science instruction of a cohort of eight early-elementary teachers in order to understand how they used language to promote students' oral language and vocabulary development. In the second study, I examined the science instruction of Ms. Thompson,

kindergarten teacher, in order to identify features of science curriculum materials that are related to enhanced vocabulary talk during science instruction. In total, 24 video recorded science lessons provided 894.27 minutes of observational data across three timepoints from the eight participating teachers. I used discourse analysis and other qualitative analysis techniques to examine the vocabulary talk moves (i.e., ways of using language to promote oral language and vocabulary development) the teachers made during science instruction. I also used quantitative techniques to make within- and between-teacher comparisons of vocabulary talk over the course of the study.

The cohort of teachers used considerably more vocabulary talk moves for building students' knowledge of word meanings than for scaffolding students' word use, building students' awareness of words and word learning, or interesting students in words and word learning. This study points to the need to consider the context in which vocabulary talk moves are made and the overall quality of this vocabulary talk in addition to examining which moves the teachers make. Curriculum materials that (a) identified target words and provided child-friendly explanations/definitions, (b) used texts that highlight these target words and provided supports for extra-textual talk promoting vocabulary talk, and (c) offered discussion prompts that deepen students' understandings of target word meanings were associated with enhanced vocabulary talk by Ms. Thompson. Likewise, the absence of these curricular features was associated with less vocabulary talk.

This study contributes to the field's understanding of the ways that science instruction supports literacy learning and literacy instruction supports science learning in the early-elementary grades. The findings from this study have implications for curriculum development, teacher professional development, teacher preparation, and policy.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1—INTRODUCTION

Statement of the Issue

Oral language and vocabulary development in the early-elementary grades is important for students' overall academic success. Vocabulary knowledge has long been established as having a significant impact on literacy learning, as understanding the meaning of words in text is central to comprehending the text (Anderson & Freebody, 1981; Davis, 1944; Ouellette & Beers, 2010). Knowing the meaning(s) of many words supports comprehension and as such, the size of students' vocabularies is predictive of both concurrent (Ricketts et al., 2007) and later (Senechal et al., 2006) reading comprehension. This impact is not limited to literacy learning, as oral language and vocabulary support science learning as well (e.g., Mercer et al., 2004; Richmond & Striley, 1996; Wright & Gotwals, 2017). Reciprocally, the background knowledge and vocabulary students gain when learning about the natural world supports their reading comprehension (e.g., Guthrie, Anderson, Alao, & Rinehart, 1999; Wang & Herman, 2006). Therefore, oral language and vocabulary development should be an essential focus of instruction for early-elementary students—including within science instruction.

As such, current national standards for literacy and science instruction each emphasize oral language development. The Common Core State Standards (CCSS) call for students to engage in substantive talk, beginning in the early-elementary grades (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). In order to meet Listening and Speaking English Language Arts standards, kindergarteners, for instance, are expected to participate in collaborative conversations; follow agreed-upon rules for discussions; continue a conversation through multiple exchanges; ask and answer questions to confirm understanding, seek help, get information, or clarify something not understood; provide

descriptions; and express thoughts, feelings, and ideas clearly. Similarly, the Next Generation Science Standards (NGSS) call for students to engage in the kinds of talk that scientists do, beginning in kindergarten (NGSS Lead States, 2013). To meet these standards, kindergarteners need to be able to describe patterns, share observations, construct arguments supported by evidence, ask questions to obtain information, and communicate solutions (NGSS Lead States, 2013; Wright & Gotwals, 2017). Thus, science instruction aligned to these ambitious standards would provide many opportunities for supporting early-elementary students' language and literacy development (Wright & Domke, 2019).

Although instruction supporting students' oral language and vocabulary development is essential for early-elementary students' academic success, studies show that very little time is devoted to vocabulary instruction (Nelson et al., 2015; Scott et al., 2003; Wright & Neuman, 2014) or science instruction (Berliner, 2011; Blank, 2012) at the elementary level. Further, studies have found that the quality of the vocabulary instruction that does occur in schools is not reflective of *effective* vocabulary instruction (Carlisle et al., 2013; Scott et al., 2003; Watts, 1995; Wright & Neuman, 2014). Relatedly, Dickinson, Darrow, and Tinubu (2008) reported there being "substantial room for improvement" in supporting young children's language and learning (p. 420). Similarly, Windschitl, Thompson, Braaten, and Stroupe (2012) identified generating student talk and using it as a social resource for learning as an area for growth within science instruction.

Given the importance of oral language and vocabulary development for academic success, it is critical to understand how teachers support this development during typical classroom instruction. Researchers have examined various aspects of teachers' vocabulary instruction through observations in preschool, elementary, and middle-grades classrooms. Most

of these observational studies have taken place within the context of literacy instruction (Blachowicz, 1987; Carlisle et al., 2013; Nelson et al., 2015; Neugebauer et al., 2017; Silverman et al., 2014; Silverman & Crandell, 2010; Wanzek, 2014; Watts, 1995). Blachowicz (1987) focused on vocabulary instruction in six 20-40-minute reading groups in fourth-grade classrooms across 10-15 school days. Blachowicz found that 15-20% of instructional time was spent on vocabulary instruction; vocabulary instruction was often guided by the contextual sentences offered by the teachers' manuals; and vocabulary instruction was undifferentiated, nonstrategic, and unaligned with the reading selection's comprehension goals. Watts (1995) focused on how teachers taught vocabulary during reading lessons in 47 observations in upper-elementary classrooms in a large urban school district. Watts found that new words were taught most often as a prereading activity; teachers used definitional and contextual types of instruction most often; and many features of effective vocabulary instruction were rarely observed, including activating prior knowledge, providing multiple exposures to words, and teaching strategies for independent word learning. Silverman and Crandell (2010) focused on the correlation between teachers' vocabulary instructional practices and prekindergarten and kindergarten students' vocabulary, completing three 90-minute observations in each of 16 classrooms in an urban school district. They found that the effectiveness of acting out/illustrating the meaning of words, prompting students to analyze how words are related, guiding students use words productively in novel contexts, defining words, and prompting students to use vocabulary words during word study varied based on students' initial vocabulary knowledge and whether the practices were used during read-aloud time or non-read-aloud time. Carlisle et al. (2013) focused on teachers' support for students' vocabulary learning during literacy instruction at four different timepoints in 44 third-grade classrooms in high-poverty schools. Carlisle found that teachers rarely engaged

students in cognitively challenging work on word meanings, the extent to which teachers supported students' vocabulary development was significantly related to reading comprehension gains across the school year, and the quality of support teachers provided for students' vocabulary learning was related to teachers' knowledge of reading and reading instruction. Wanzek (2014) focused on the amount and type of direct vocabulary instruction provided for second-grade students with reading difficulties during core reading instruction and supplemental reading interventions by 14 classroom and intervention teachers in three Title I schools. Wanzek found that 8% of core classroom reading instruction was devoted to direct vocabulary instruction (i.e., providing definitions and examples) and minimal direct vocabulary instruction occurred during supplemental reading interventions. Silverman et al. (2014) focused on the relationship between teachers' reading/language arts instruction and third-, fourth-, and fifth-grade students' vocabulary and comprehension, observing 33 classrooms at three points during a school year. They found that instruction related to definitions, word relations, and morphosyntax was positively associated with change in vocabulary, while instruction related to application of words across contexts was negatively associated with change in vocabulary (likely due to poor quality of application of words across contexts). Nelson et al. (2015) focused on teachers' vocabulary instruction during language arts lessons in K-3 classrooms in low-income schools, with 337 observations across three years. They found that less than 5% of the language arts block was devoted to vocabulary instruction, with most of that time focused on teaching individual words rather than word-learning strategies. Neugebauer et al. (2017) focused on a specific aspect of vocabulary instruction—*word consciousness talk* (i.e., talk that reinforced students' use of words, affirmed their recognition of words, and helped students make personal connections to words)—within the context of a vocabulary intervention (i.e., Elements of Reading Vocabulary;

Beck & McKeown, 2004) in 27 kindergarten classrooms in urban schools. Neugebauer and colleagues found that teachers' word conciousness talk was positively associated with student gains in general vocabulary at the end of kindergarten. Collectively, these studies offer insight into the nature of vocabulary instruction within literacy lessons—namely, that little time is devoted to vocabulary instruction and often this instruction lacks features of effective vocabulary instruction.

Only a few observational studies have examined vocabulary instruction outside of literacy instruction (Dickinson et al., 2008; Scott et al., 2003; Wright & Neuman, 2014). Scott et al. (2003) focused on when, where, and how often effective vocabulary instruction occurred across the school day (including math, science, art, and social studies) within 308 hours of instruction in upper-elementary middle school classrooms in three diverse districts in Canada. Scott and colleagues found that 6% of school time was devoted to developing vocabulary knowledge, with only 1.4% of school time devoted to vocabulary development outside of langauge arts instruction (e.g., science, social studies, mathematics, art). Dickinson et al. (2008) focused on how four Head Start teachers used four evidence-based strategies (i.e., varied vocabulary, extended talk on a single topic, semantically-contingent responses, and cognitively-rich topics of conversation) within the context of centers time (i.e., blocks and dramatic play) on three different occasions. They found that teachers asked thought-provoking questions and engaged students in extended topic discussions more often than they responded to children's questions or initiatives, modeled sophisticated language, provided explanations, or engaged in conceptually-based instruction. Wright and Neuman (2014) focused on how teachers enacted oral vocabulary instruction across the full school day in 660 hours of observation across four school days in 55 kindergarten classrooms from a range of socio-economic status schools. They

found that teachers gave single, brief word explanations in order to support students' understanding of the immediate context (i.e., teachable moments); engaged in more vocabulary instruction during subject areas (e.g., science and social studies) but devoted little time to these areas overall; and explained words more often and were more likely to address sophisticated words when serving in economically advantaged schools than disadvantaged schools.

In short, little is known about how teachers promote oral language and vocabulary development in science instruction in the early-elementary grades, with only one observational study (Wright & Neuman, 2014) including science instruction at the K-2 level. Therefore, given the importance of oral language and vocabulary development to students' literacy and science learning and the emphasis placed on oral language development by national standards, there is a clear need to better understand how teachers at the early-elementary grades develop students' oral language and vocabulary within science instruction. The purpose of the present observational study is to examine teachers' *vocabulary talk moves*—that is, ways of using language to promote oral language and vocabulary development—during science instruction in early-elementary classrooms. Understanding the ways in which teachers do and do not use vocabulary talk moves during science instruction in the early-elementary grades is important because it allows us to examine the opportunities for students to develop oral language and vocabulary and simultaneously access science content, both of which can ultimately support reading comprehension (Anderson & Freebody, 1981; Kintsch, 2013).

Overview of the Present Study

As little is known about how teachers promote oral language and vocabulary development in science instruction in the early-elementary grades, the purpose of the present study is to examine the vocabulary talk moves (i.e., ways of using language to promote oral

language and vocabulary development) teachers make during science lessons. Data for this study were collected as part of the **S**cience, **O**ral Language, and **Li**teracy **D**evelopment from the **Start** of School (SOLID Start) project (Dr. Tanya Wright & Dr. Amelia Gotwals, PIs), with funding from the National Science Foundation (NSF; grant number 1620580). I analyzed 894.27 minutes of observational data across 24 total science lessons in eight early-elementary classrooms (i.e., one young 5s, three kindergarten, two first grade, and two second grade) located in the same elementary school in a small district within a large Midwestern state. Participating teachers' science lessons were recorded at three points during February through May of 2019. Discourse analysis and other qualitative analysis techniques were used to examine the vocabulary talk moves the teachers made during science instruction. Quantitative techniques were also used to make comparisons of vocabulary talk over the course of the study.

I present descriptive findings investigating how teachers use vocabulary talk moves during science instruction. I examine the specific vocabulary talk moves teachers make and the frequency with which these moves are made during a lesson. I make within- and between-teacher comparisons of vocabulary talk over the course of the study and examine the relationship between vocabulary talk and the language aspects of science talk. I also report on curricular features related to enhanced vocabulary talk. The following research questions are addressed in this study:

1. How do teachers use language to promote students' oral language and vocabulary development during science instruction in early-elementary classrooms?
2. Is vocabulary talk related to the language aspects of science talk, and if so, how?
3. What features of science curriculum materials are related to a kindergarten teacher's enhanced vocabulary talk?

Contribution of the Study

In order to support teachers with implementing effective oral language and vocabulary instruction that enables students to meet ambitious national standards and ultimately promotes their literacy and science learning, we must first understand the current state of oral language and vocabulary instruction within the context of science lessons in early-elementary classrooms. Observational studies of vocabulary instruction have primarily focused on the ways in which teachers support vocabulary development within the context of literacy instruction (e.g., Blachowicz, 1987; Carlisle et al., 2013; Nelson et al., 2015; Neugebauer et al., 2017; Silverman et al., 2014; Silverman & Crandell, 2010; Wanzek, 2014; Watts, 1995). At this time, we have very limited knowledge about how teachers promote oral language and vocabulary development within science instruction in the early-elementary grades. Understanding what opportunities there are for building students' vocabulary outside of literacy instruction is important given the sheer number of vocabulary words there are to learn (Anderson & Nagy, 1992; Nagy & Anderson, 1984), little time is devoted to vocabulary instruction within literacy instruction (Blachowicz, 1987; Nelson et al., 2015; Wanzek, 2014), and many words have discipline-specific meanings (Bravo & Cervetti, 2008). This study contributes to the research base by examining how teachers use language to promote oral language and vocabulary development during science instruction in the early-elementary grades, whether/how vocabulary talk relates to the language aspects of science talk, and what features of science curriculum materials are related to enhanced vocabulary talk. In doing so, this study contributes to the field's understanding of the ways in which science instruction supports literacy learning and literacy instruction supports science learning. By gaining a better understanding of the current state of oral language and vocabulary instruction within early-elementary science lessons, we can design

professional development and curriculum materials to support teachers in implementing effective oral language and vocabulary instruction.

CHAPTER 2—CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

This chapter focuses on the conceptual framing of the present study and the research relative to how children learn words and why opportunities for oral language and vocabulary development should be examined within the context of science instruction. First, I present the theoretical and empirical work that frames this study. Then, I highlight research-based instructional practices for supporting children's oral language and vocabulary development in early childhood and throughout the elementary grades. Finally, I present research supporting the integration of language and literacy instruction with science instruction.

Conceptual Framework

This study is framed by theoretical and empirical work centered around language learning, particularly as it pertains to the ways children's vocabularies develop through oral language in classroom settings. In this section, I discuss the theories and research relative to how language development occurs through interpersonal interactions (e.g., Vygotsky, 1978, 1986); language is used to carry out specific actions (Gee, 2014); language learning is an unconstrained skill (Neuman & Wright, 2013; Paris, 2005) and therefore requires multifaceted instruction (e.g., Baumann et al., 2007; Carlo et al., 2004; Lesaux & Kieffer, 2010; National Institute of Child Health and Human Development, 2000); and language learning is supported by an individual's awareness of and interest in words and word learning (Anderson & Nagy, 1992; Graves & Watts-Taffe, 2002, 2008).

Social Nature of Language Learning

The present study draws on the social interaction theory of language acquisition (Bohannon & Bonvillian, 2001), which posits that language develops through interpersonal interactions. Vygotsky (1978, 1986) particularly emphasized the role the adults in a child's life

play in supporting the child's language acquisition. Likewise, Bruner (1978) suggested that parents provide a supportive communicative structure (i.e., scaffold) that facilitates language development. From the social interaction perspective, classroom teachers play a significant role in the language development of their students, as they expose students to language through both talk and texts.

Empirically, many studies with young children have found a relationship between the talk of adults and the oral language and vocabulary development of children (e.g., Barnes et al., 2017; Barnes & Dickinson, 2017, 2018; E. P. Bowers & Vasilyeva, 2011; Dickinson et al., 1993; Dickinson & Porche, 2011; Dickinson & Smith, 1994; Dickinson & Tabors, 1991; Wasik & Hindman, 2014). For example, Dickinson and Tabors (1991) found that engaging young children in certain kinds of conversational language experiences, such as explanatory and narrative talk at mealtimes at home and interactive read-alouds at school, supported the development of their vocabulary and other literacy-related language skills. Relatedly, Dickinson, Cote, and Smith (1993) found that engaging young children in intellectually challenging discussions fostered language growth. Likewise, Dickinson and Smith (1994) found a strong association between teacher-child interactions involving predictions, talk about vocabulary, and analysis (i.e., child-involved analytic talk) and vocabulary development. Further, Dickinson and Porche (2011) found that preschool teachers' sophisticated use of language was predictive of students' reading comprehension and word recognition in fourth grade. They also found that, in addition to early support in the home for literacy, preschool teachers' utterances that (a) corrected the accuracy of what children said and (b) analyzed word meanings or reasons for characters' actions or story events in read-aloud texts was predictive of students' vocabulary in fourth grade. In a related study, E. P. Bowers & Vasilyeva (2011) found that the number of different words (i.e., word

types) a preschool teacher used was positively related to vocabulary growth for monolingual children, while the number of total words a preschool teacher used was positively related to vocabulary growth for children learning English. In another study, Barnes et al. (2017) found that preschool children's receptive vocabulary growth was positively associated with teachers' comments related to science, social studies, mathematics, texts, or metacognition (i.e., conceptually-focused comments). They also found that children in classrooms where teachers were more responsive (i.e., teachers comment immediately after a child's utterance to extend the topic of conversation with additional information or an answer to a question) experienced greater receptive vocabulary growth than children who experienced less interaction. Similarly, Barnes and Dickinson (2017) found that preschool children experienced greater receptive vocabulary growth when they were in classrooms in which teachers used more lexical elements (i.e., amount, sophistication, and diversity of vocabulary and shorter utterances). Relatedly, Barnes and Dickinson (2018) found that teachers' use of mental state verbs (i.e., verbs expressing cognition through thoughts, memories, knowledge, feelings, or ideas) was positively associated with preschool children's end-of-year receptive vocabulary scores. Further, they found a positive association between teacher talk that placed the child as the referent of the mental state verb in group content instruction and children's end-of year receptive vocabulary scores.

Together, these studies demonstrate the significant impact the language use of adults has on the language development of children. Because of the important role adult speech plays in children's language learning, I examined the oral language interactions that happened between the teachers and their early-elementary students in the present study. This is important because little is known about oral language interactions regarding vocabulary learning within the context of science instruction in the early-elementary grades.

Action Through Language

The present study also draws on Gee's (2014) notion that language is used to carry out specific actions rather than just to give one another information. Therefore, in the context of an early-elementary classroom, teachers likely use language in many different ways to carry out actions with specific pedagogical purposes. This notion of action-through-language provides theoretical support for research on teachers' use of *talk moves*—or specific ways of using language to achieve specific outcomes (e.g., Michaels & O'Connor, 2015). Researchers have examined teachers' language use to understand the specific talk moves they make to carry out instructional actions through language (Beck et al., 1996; McKeown & Beck, 2004; Michaels & O'Connor, 2015; Michener et al., 2018; O'Connor & Michaels, 1993, 1996, 2019). For example, Beck et al. (1996) and McKeown and Beck (2004) examined fourth-grade teachers' talk within the context of the Questioning the Author intervention and identified specific talk moves teachers made when asking questions (i.e., retrieving information from the text, constructing the message of the text, extending discussion, checking students' knowledge of specific information) and responding to students' comments (i.e., repeating the comment, paraphrasing the comment, refining the comment). They found that when teachers asked questions focused on constructing and extending meaning and gained skill in refining and using students' comments in discussion, the amount of teacher talk decreased while the quality of talk increased. Similarly, Michener et al. (2018) investigated how rates of specific talk moves of third-, fourth-, and fifth-grade teachers predicted students' reading comprehension. Controlling for students' decoding and fluency, semantic-syntactic knowledge, and initial reading comprehension, they found that teacher explanations and simple follow-up moves (i.e., low-level evaluations) significantly predicted students' reading comprehension. In the present study, I examined the *vocabulary talk moves*

teachers made—or specific ways of using language to promote oral language and vocabulary development. This is important because the talk moves identified in previous studies have not centered on vocabulary instruction within the context of early-elementary science instruction. The present study identifies teachers' talk moves that are aligned with the literature on how children learn words.

Complex Nature of Word Learning

The present study is also framed by the understanding that the task of word learning is complex. In contrast to constrained skills such as learning the names of the 26 letters of the English alphabet, learning vocabulary is an unconstrained skill; that is, there are always more words to learn and individuals continue to learn new words throughout their lifetime (Neuman & Wright, 2013; Paris, 2005). Adding to the challenge of learning thousands of words, many words have multiple meanings (Anderson & Nagy, 1992; Graves, 2006; Nagy & Anderson, 1984). Relatedly, word learning is an incremental process, with depth and breadth of word knowledge developing over time through multiple exposures to words in a variety of contexts (Beck et al., 1987; Blachowicz et al., 2013; Dale, 1965; Nagy & Scott, 2000). Further complicating word learning, context is not always helpful in determining the meaning of a word (Beck et al., 1983), and dictionary definitions can confuse rather than clarify a word's meaning(s) (McKeown, 1993).

Given the complex nature of word learning, vocabulary researchers recommend instruction that is multifaceted, meaning that multiple approaches are used to address different aspects of word learning (e.g., Baumann et al., 2007; Carlo et al., 2004; Lesaux & Kieffer, 2010; National Institute of Child Health and Human Development, 2000). Teaching students the meaning(s) of individual words is one effective approach (Beck & McKeown, 2007; Jenkins et

al., 1989; McKeown, 1985); however, because there are far too many words to directly teach students each word's meaning(s) (Nagy et al., 1985; Nagy & Anderson, 1984; Nagy & Herman, 1985), vocabulary researchers also recommend supporting students in becoming independent word learners (Anderson & Nagy, 1992; Graves, 2006; Nagy, 2005). This is also important because, while incidental word learning (i.e., unintentionally learning words from texts while reading) does occur (Nagy et al., 1984, 1985), students learn only about 15% of the unknown words they encounter in a text (Swanborn & de Glopper, 1999). Therefore, to substantially contribute to students' vocabulary development, researchers also recommend teaching students specific strategies to use when they encounter unfamiliar words and developing their awareness of how words work and how they learn and think about words (Baumann et al., 2007; Graves, 2006; Nagy, 2005; Wise, 2019). In the present study, I examined the range of instructional practices that might support oral language and vocabulary development. This study builds on previous work by examining these instructional practices within the context of early-elementary science instruction.

Word Consciousness and Word Learning

Finally, the present study draws on the theory of word consciousness, which posits that students' knowledge and dispositions for learning, appreciating, and effectively using words generatively supports their vocabulary development (Scott & Nagy, 2004). Specifically, *word consciousness* refers to students' awareness of and interest in words and word learning, as well as their ability to use what they know about words to learn new words (e.g., Anderson & Nagy, 1992; Graves & Watts-Taffe, 2002, 2008). Vocabulary researchers have suggested that how students feel about words and word learning impacts how (if) they engage in word learning (e.g., Scott & Nagy, 2004). They posit that for students to engage in the work of figuring out the

meaning(s) of an unfamiliar word, they need to view word learning as worthwhile and be curious enough about a word's meaning to attempt to figure out its meaning (Anderson & Nagy, 1992; Scott & Nagy, 2004). Theoretically, students who are aware of words, have knowledge of words and word learning, have interest in words, and are motivated to learn new words are more likely to learn the new words they encounter than students with less awareness, knowledge, interest, or motivation.

The literature on these affective factors has been primarily theoretical (e.g., Anderson & Nagy, 1991, 1992; Graves, 2000, 2006; Graves & Watts-Taffe, 2002, 2008; Nagy & Scott, 2000; Scott & Nagy, 2004). Several studies have included instruction addressing affective factors within a larger vocabulary program (e.g., Baumann et al., 2007; Cox et al., 2015; Coyne et al., 2010; Manyak et al., 2014; McKeown et al., 1983, 1985; Taboada & Rutherford, 2011). For example, Baumann et al. (2007) included word play and figurative language activities in their multifaceted intervention. However, as part of a larger vocabulary program, it is not possible to determine the impact these affective factors, in particular, had on students' vocabulary development. One study has specifically examined the efficacy of instruction targeting affective factors on students' word learning. Neugebauer et al. (2017) investigated the impact of teachers' *word consciousness talk*—defined as talk that reinforces students' use of words, affirms their recognition of word meanings, and helps them make personal connections to words—on kindergarten students' general vocabulary knowledge. In this observational study, Neugebauer and colleagues examined teachers' language use within the context of their designated vocabulary instruction time, which made use of the Elements of Reading Vocabulary program (Beck & McKeown, 2004). Neugebauer and colleagues found that teachers' word consciousness talk was positively associated with gains in kindergarten students' general vocabulary knowledge

at the end of the school year. In the present study, I considered how the teachers' talk addressed affective factors such as these.

In summary, in the present study, I examined the oral language interactions between teachers and students in early-elementary classrooms to identify teachers' vocabulary talk moves. When identifying these vocabulary talk moves, I considered the range of instructional practices that research has shown to support oral language and vocabulary development (i.e., building knowledge of word meanings, scaffolding students' word use, and building awareness of words and word learning—detailed in the next section), along with practices that addressed affective factors based on the theory of word consciousness.

How Children Learn Words

The research on how children learn words aligns with three broad instructional approaches: building knowledge of word meanings, scaffolding students' word use, and building awareness of words and word learning. In the following sections, I present an overview of the literature related to each approach. Specifically, I focus on studies at the preschool and elementary levels. It is important to note that a majority of studies that examine how children learn words have been conducted within the context of some sort of interactive read-aloud experience in which an adult (i.e., typically the teacher) reads a text aloud to children and engages children in that reading experience in a variety of ways (e.g., Barnes & Dickinson, 2018; Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; Dickinson & Smith, 1994; Dickinson & Tabors, 1991; Hadley et al., 2019; McKeown & Beck, 2003; Silverman, 2007a, 2007b; Silverman & Crandell, 2010; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014). In this context, children are exposed to language through the text itself and through *extra-textual talk*, or the talk that happens around the text (Biemiller &

Boote, 2006; National Institute of Child Health and Human Development, 2000; Wright, 2018). Only a few of the studies examining how children learn words have been conducted outside of literacy instruction (e.g., Baumann et al., 2003; Freeman et al., 2019; Lubliner & Smetana, 2005).

Knowledge and Understanding

The most researched approach to vocabulary instruction is building students' knowledge of word meanings. This is unsurprising, as understanding word meanings—whether learning the meaning of an unfamiliar word or learning a new meaning for a familiar word—is at the core of vocabulary development. Studies have consistently shown that providing students with explanations or definitions of the meanings of target words (i.e., words that have been targeted for instruction) promotes students' understanding of those words (e.g., Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; McKeown et al., 1983, 1985; McKeown & Beck, 2003; Nash & Snowling, 2006; Silverman, 2007a, 2007b; Silverman et al., 2014; Silverman & Crandell, 2010; Stahl & Fairbanks, 1986; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014). For example, Biemiller and Boote (2006) found that providing kindergarten, first-, and second-grade students with explanations of target words during interactive read-alouds was more effective than not providing explanations, with a pretest-posttest gain of 22% for instructed words vs. 12% for uninstructed words. Likewise, Coyne et al. (2007, 2009) found that kindergarten students scored significantly higher on vocabulary measures for target words for which they received simple definitions than with target words they encountered in text without explanation or discussion (i.e., incidental exposure).

Studies have also consistently shown that introducing target words within rich contexts (e.g., interactive read-alouds) and discussing the meaning(s) of target words in various contexts

supports students' understanding of target word meaning(s) (e.g., Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; McKeown et al., 1983, 1985; McKeown & Beck, 2003; National Institute of Child Health and Human Development, 2000; Silverman, 2007a, 2007b; Silverman et al., 2014; Silverman & Crandell, 2010; Stahl & Fairbanks, 1986; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014). For example, using a within-subjects comparison, Coyne et al. (2007) found that kindergarten students scored significantly higher on expressive and receptive measures of target word definitions and on a measure of understanding target words in a novel context when they engaged in activities that allowed them to interact with and discuss target words in a variety of meaningful contexts compared to when they received just incidental exposure to target words during interactive read-alouds.

Multiple exposures to target words is another tenet of vocabulary instruction that promotes understanding of word meanings (e.g., Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; McKeown et al., 1983, 1985; McKeown & Beck, 2003; National Institute of Child Health and Human Development, 2000; Robbins & Ehri, 1994; Silverman, 2007a, 2007b; Silverman & Crandell, 2010; Stahl & Fairbanks, 1986; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014). For example, McKeown et al. (1983) and McKeown et al. (1985) compared the effectiveness of two different frequencies of instructional encounters with target words and found that more frequent encounters with target words led to better outcomes for fourth-grade students on measures of definition knowledge, fluency of access to word meanings (i.e., lexical access), understanding of word meaning in a specific context (i.e., context interpretation), and story comprehension. Similarly, Beck and McKeown (2007) found that vocabulary gains were twice as large for kindergarten and first-grade students

with words receiving six days of instruction with 20 total encounters per target word compared to words receiving three of days of instruction with five total encounters per target word.

Many studies have also shown that understanding of word meanings is developed by engaging students in *active processing* or *deeper processing*—that is, engaging students with words and their meanings beyond just associating a word with its meaning (e.g., Beck & McKeown, 2007; Coyne et al., 2007, 2009, 2010; McKeown, 1985; McKeown et al., 1983; National Institute of Child Health and Human Development, 2000; Silverman, 2007a, 2007b; Silverman & Crandell, 2010; Stahl & Fairbanks, 1986; Wasik et al., 2016; Wasik & Bond, 2001; Zipoli et al., 2011). For example, McKeown et al. (1985) found that students who explored various aspects of target word meanings—such as by identifying relationships between words, responding affectively and cognitively to words, and applying words to various contexts—performed better on measures of context interpretation (i.e., understanding of word meaning in a specific context) and comprehension of text containing target words than students who were just encouraged to make a simple association between each target word and its definition or synonym. Similarly, Coyne et al. (2007, 2009) found that engaging kindergarten students in deeper processing activities such as recognizing examples of target words, answering questions about target words, producing sentences with target words, and answering questions containing more than one target word (i.e., extended instruction) produced significantly higher scores on vocabulary measures than instruction in which (a) a simple definition was provided for target words as they were encountered in text (i.e., embedded instruction) or (b) target words were encountered in text with no discussion or explanation (i.e., incidental exposure).

Studies have also shown that providing students with an image depicting a target word (e.g., Coyne et al., 2009, 2010; Rosenthal & Ehri, 2008; Silverman, 2007a; Silverman et al.,

2014; Silverman & Crandell, 2010; Wasik et al., 2016; Wasik & Bond, 2001), showing an object representing a target word (e.g., Silverman et al., 2014; Wasik et al., 2006; Wasik & Bond, 2001; Wasik & Hindman, 2014), and/or acting out or demonstrating a target word—or engaging students in doing so—(e.g., Silverman, 2007a; Silverman et al., 2014; Silverman & Crandell, 2010) can be effective methods for building students' understanding of word meanings. While many studies have included these components within multicomponent vocabulary instruction and examined the overall impact of these interventions (e.g., Silverman, 2007a, 2007b; Wasik et al., 2006, 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014), Silverman and Crandell (2010) examined the relationship between specific vocabulary instruction practices and prekindergarten and kindergarten students' vocabulary. They found that providing a visual support (e.g., picture) and/or kinesthetic cue (e.g., gesture) during interactive read-aloud time was positively associated with vocabulary growth on a standardized measure of general vocabulary knowledge for children with lower initial vocabulary knowledge but was negatively associated with vocabulary growth for children with higher initial vocabulary knowledge. This suggests that these practices may be beneficial for building vocabulary knowledge with some students.

Multicomponent vocabulary instruction often includes highlighting examples or nonexamples that illustrate what target words mean (e.g., Beck & McKeown, 2007; Coyne et al., 2007, 2009, 2010; Silverman, 2007a; Silverman et al., 2014). For instance, Beck and McKeown (2007) provided first-grade students with multiple examples of target words in multiple contexts. Likewise, Coyne et al. (2007, 2009, 2010) provided kindergarten students with examples of how target words are used and engaged students in determining whether or not a picture was an example of a target word. Similarly, Silverman's (2007a) Multidimensional Vocabulary Program included providing kindergarten students with examples to show how target words are used in

contexts outside of the initial text in which they were introduced. Although these studies of multicomponent vocabulary instruction did not examine the specific impact of highlighting examples of target words, instruction that included examples was found to be effective.

Many studies have also suggested that drawing students' attention to the spelling of target words by showing students the words in print (i.e., providing orthographic information) and/or drawing students' attention to the sounds in target words (i.e., highlighting phonological information) promotes learning the meanings of those words (e.g., Chambrè et al., 2019; Ehri, 2014; Ehri & Rosenthal, 2007; Jubenville et al., 2014; Juel & Deffes, 2004; Ricketts et al., 2009; Rosenthal & Ehri, 2008; Silverman, 2007a, 2007b; Silverman & Crandell, 2010). For example, Rosenthal and Ehri (2008) found that showing second- and fifth-grade students target words in print enhanced their memory for pronunciations and meanings of those words compared to target words that were not shown. Further, they found that fifth-grade students with more orthographic knowledge benefitted more from seeing target words in print than students with less orthographic knowledge. In a related study, Silverman (2007b) found that kindergarten students who received vocabulary instruction that included attention to letters and sounds in target words had significantly higher scores on a receptive measure of target word knowledge six months later, when tested in first grade, compared to students whose vocabulary instruction did not attend to the orthographic and phonological aspects of target words. Likewise, Silverman and Crandell (2010) found a positive relationship between instruction in which prekindergarten and kindergarten teachers called attention to the sounds or spelling of vocabulary words during interactive read-alouds and students' vocabulary growth. However, not all studies examining the impact of showing target word spellings on students' understanding of these words have found this practice to be effective. Chambré et al. (2017) found that while first-grade students' memory

for pronunciation of target words was improved by seeing target words in print, their memory for target word meanings was not improved by this exposure to target word spellings. Chambré and colleagues speculated that this lack of connection between spelling and meaning may be caused by the lack of a grapho-semantic mapping system comparable to the grapho-phonemic system—at least for the target words examined in their study. They hypothesized that students' memory for target word meanings might be improved by seeing target words in print if those target words contained familiar letter patterns representing root words and affixes. Therefore, the benefit of showing students target words in print may depend, at least in part, on orthographic features of those words.

To support students' understanding of target word meanings, studies have incorporated systematic review of these words within their instructional sequence (e.g., Beck & McKeown, 2007; Biemiller & Boote, 2006; Coyne et al., 2010; McKeown, 1985; McKeown et al., 1983; Silverman, 2007a; Zipoli et al., 2011). Many of these studies have included target word review as one part of multicomponent vocabulary instruction and examined the overall impact of these interventions (e.g., McKeown et al., 1983, 1985; Silverman, 2007a); however, Zipoli et al. (2011) specifically examined the relationship between systematic word review and target word learning. Within an 18-week program of extended vocabulary instruction (i.e., instruction promoting deeper processing of target words through extension activities) with kindergarten students, they found that students performed twice as well on a measure of target word knowledge with words that were systematically reviewed than with words in the no review comparison condition.

Finally, studies have shown that teaching target words in conceptually- or semantically-related sets promotes students' knowledge of word meanings (e.g., Cervetti et al., 2016; Hadley

et al., 2019; Neuman et al., 2011; Neuman & Dwyer, 2011; Neuman & Kaefer, 2013, 2018; Pollard-Durodola et al., 2011; Zipoli et al., 2011). For example, Neuman et al. (2011) found that preschool children who were taught target words within taxonomic categories (i.e., grouping of objects based on shared properties) outperformed children in the comparison condition on measures of word knowledge, expressive language, conceptual knowledge, and categories and properties of concepts. Further, children receiving the intervention were able to use categories to determine the meaning of novel words. Similarly, Hadley et al. (2019) compared the effects of teaching words in taxonomic groups (e.g., *vegetables: artichoke, cauliflower, eggplant*) verses themes (e.g., *vines, raw, soil*) on preschool children's growth in vocabulary depth. They found that preschool children showed greater growth in vocabulary depth for words taught in taxonomies than for words taught in themes and learned information about category membership, perceptual features, and object function more deeply for words in the taxonomy condition than for words in the theme condition. Likewise, Cervetti et al. (2016) found that fourth-grade students who read a set of conceptually-coherent informational texts (i.e., texts that cohered around a set of concepts related to a topic) showed greater knowledge of concepts in their texts, greater knowledge of target words in their texts, and greater recall of novel text compared to students who read a set of unrelated informational texts. In a related study, Zipoli et al. (2011) found that kindergarten students learned significantly more target words with semantically-related review (i.e., systematic review that draws attention to the semantic features of words and emphasizes associations between target words and familiar words and concepts) than with embedded review (i.e., systematic review that defines target words as they appear in various texts beyond the initial text in which they were introduced). Together, these studies

demonstrate that students' understanding of word meanings is supported when target words are presented in conceptually- or semantically-related sets.

In summary, these studies focused on building students' knowledge of word meanings found that students' word learning was supported by instruction that provided definitional and contextual information, multiple exposures in a variety of rich contexts, opportunities for students to engage in deeper processing than just associating a word with its meaning, visual supports (e.g., image, demonstration), examples, attention to target word spelling and/or sounds, and systematic review. Presenting target words in conceptually- or semantically-related sets was also found to build students' knowledge of word meanings. In the present study, I identified the ways in which teachers used language to build students' knowledge of word meanings that aligned with this research base.

Student Word Use

The research on scaffolding students' word use overlaps widely with the research on building students' knowledge of word meanings, as many studies have examined multicomponent vocabulary instruction that includes opportunities for students to engage in using the target words (e.g., Beck & McKeown, 2001, 2007; Coyne et al., 2007, 2009, 2010; McKeown, 1985; McKeown et al., 1983; McKeown & Beck, 2003; Silverman, 2007a, 2007b; Wasik & Bond, 2001). A common practice in vocabulary instruction is to encourage students to repeat (pronounce) target words in order to create phonological representations of them (e.g., Beck & McKeown, 2001, 2007; Coyne et al., 2007, 2009, 2010; Juel & Deffes, 2004; McKeown et al., 1983, 1985; McKeown & Beck, 2003; Rosenthal & Ehri, 2011; Silverman, 2007a; Silverman & Crandell, 2010; Zipoli et al., 2011). For example, as part of the Text Talk approach to vocabulary instruction (Beck & McKeown, 2001, 2007; McKeown & Beck, 2003),

kindergarten and first-grade students are encouraged to say target words aloud as part of their introduction. While many of these studies included the practice of asking students to say target words aloud within multicomponent vocabulary instruction and investigated the overall impact of this instruction, Rosenthal and Ehri (2011) specifically examined the impact of pronouncing target words aloud on students' word learning. They found that encouraging fifth-grade students to say aloud target words as they were encountered in contextually supportive passages during silent reading promoted vocabulary learning, with larger effect sizes for students who initially scored lower on a measure of word identification.

Beyond pronouncing target words, many studies have engaged students in some form of deeper processing (as promoted by Stahl & Fairbanks, 1986) that required students to use the target words in speech or writing (e.g., Beck & McKeown, 2007; Coyne et al., 2007, 2009, 2010; McKeown, 1985; McKeown et al., 1983; Silverman, 2007b; Silverman & Crandell, 2010; Wasik et al., 2016; Wasik & Bond, 2001; Zipoli et al., 2011). For example, McKeown et al. (1985) engaged students in applying target words to various contexts. Similarly, Coyne et al. (2007) engaged students in producing sentences with target words. McKeown et al. (1983, 1985) engaged students in the Word Wizard activity, which promoted students' use of target words by encouraging them to be aware of target words outside of vocabulary lessons and engage with them independently.

In summary, these studies focused on scaffolding students' word use found that students' word learning was supported by encouraging them to say target words aloud and use target words in speech or writing. In the present study, I identified the ways in which teachers used language to scaffold students' word use that aligned with this research base.

Metalinguistic and Metacognitive Awareness

Another approach to vocabulary instruction is to build students' awareness of words and word learning by attending to their metalinguistic and metacognitive awareness. As Scott and Nagy (2004) explained, *metalinguistic awareness* refers to the ability to reflect on and manipulate language units. This includes *morphological awareness*, or the awareness of word parts and how the meanings of those parts contribute to the overall meaning of the word; *syntactic awareness*, or the ability to reflect on and manipulate word order at the sentence level; and *metasemantic awareness*, or the ability to reflect on word meanings. Metalinguistic awareness is a specific kind of *metacognitive awareness* (Nagy & Scott, 2000; Scott & Nagy, 2004). Wade and Reynolds (1989) defined *metacognition* as "the ability to think about and control one's own learning," which they noted is dependent on an awareness of what to learn, how to learn it, and whether or to what degree it has been learned (p. 6). Similarly, Kuhn (2000) defined metacognition as "cognition that reflects on, monitors, or regulates first-order cognition" (p. 178). The studies reviewed here focus on metalinguistic and metacognitive awareness as relating to word learning.

Many studies have found that teaching students to find and use context clues (i.e., contextual analysis) supports word learning (e.g., Baumann et al., 2002, 2003; Fukkink & de Glopper, 1998; Lubliner & Smetana, 2005; Nash & Snowling, 2006; Wise, 2019). For example, Fukkink and de Glopper (1998) investigated instruction aimed at supporting students with deliberately deriving word meanings from context while reading in their meta-analysis of 21 studies. They found that context clue instruction, in which students learn to recognize and use specific types of context clues to determine the meanings of unfamiliar words, was more effective than cloze instruction, in which students use context to fill in words that have been

removed from text; strategy instruction, in which students are taught to infer word meanings from context generally without reference to specific types of context clues; definition instruction, in which students develop conceptual understanding of what constitutes a definition; and practice-only instruction, in which students practice deriving word meanings from context without further instruction. Similarly, Nash and Snowling (2006) compared *definition instruction* (i.e., providing students with child-friendly definitions of target words) with *context instruction* (i.e., teaching students to look for clues within the given context to derive the meaning of target words) on the vocabulary knowledge of 7- and 8-year-old students with "poor existing vocabulary knowledge" (p. 335). They found that immediately following the intervention, students in both conditions showed equivalent improvement in vocabulary knowledge for target words; however, three months later, students in the context instruction condition showed significantly better expressive vocabulary, comprehended text containing target words significantly better, and could independently derive word meanings from written context. While Silverman et al. (2014) found a null effect for context clue instruction on vocabulary learning in their observational study, they posit that this may be due to the fact that context clue instruction was largely absent in their observations in third-, fourth-, and fifth-grade classrooms.

Many studies have also found that teaching students to look for word-part clues (i.e., morphemic analysis) supports word learning (Baumann et al., 2002, 2003; P. N. Bowers & Kirby, 2010; Freeman et al., 2019; Lubliner & Smetana, 2005; Silverman et al., 2014). For example, Freeman et al. (2019) used a collective case study design to explore how three first-grade students responded to a small-group intervention with explicit morphological instruction in Greek and Latin roots (e.g., *micro, bio, geo, rupt*), in which students engaged in finding the target roots in words within text, applying knowledge of root meaning to derive the meaning of

the word, and creating new words or recalling words belonging to the same morphological word family. Freeman and colleagues found that this instruction increased students' morphological awareness, as they were able to find roots in words and were developing the ability to analyze word features and look for clues to their meaning. Likewise, P. N. Bowers & Kirby (2010) found that, after controlling for initial vocabulary, fourth- and fifth-grade students who received instruction focused on morphological word structure were significantly better at identifying the base of complex words and explaining the meaning of target words and novel words with taught bases and affixes than students in the business-as-usual comparison condition.

Studies have also examined the combination of contextual analysis and morphemic analysis (e.g., Baumann et al. 2002, 2003). Baumann et al. (2002) examined the effects of (a) morphemic analysis, (b) contextual analysis, and (c) morphemic and contextual analysis on fifth-grade students' ability to recall the meanings of instructed words, to infer the meanings of uninstructed (transfer) words using morphemic and/or contextual analysis, and to comprehend text containing transfer words. They found that morphemic and contextual analysis enabled students to infer the meanings of untaught (transfer) words immediately following instruction, although this effect faded with time. Further, Baumann and colleagues found that combined morphemic and contextual instruction was just as effective in supporting students with inferring word meanings as when morphemic analysis and contextual analysis instruction were provided separately. Building on this work, Baumann et al. (2003) compared the effects of teaching fifth-grade students the meanings of textbook vocabulary words with teaching students to use morphemic and contextual clues to infer the meaning of unfamiliar words. They found that students who were taught the meanings of specific words from the textbook selection were more successful at learning the meanings of those words, while students who were taught to use

morphemic and contextual analysis were more successful at inferring the meanings of uninstructed affixed words. These students were also more successful on a delayed test at inferring the meanings of words that had word part or context clues. This suggests that teaching students to use morphemic and contextual analysis is a generative way to support word learning, extending beyond specific target words.

Another way to support students' metalinguistic and metacognitive awareness is to engage them deriving word meanings from context and then explaining the reasoning behind a definition (Cain, 2007). Cain found that 7- and 8-year-old students who explained the reasoning behind their own definition or the definition given by the experimenter made greater gains in defintion accuracy than students who just derived word meanings from context without giving an explanation. Further, Cain found that students who explained their own reasoning had greater insight into how the meaning was derived than students who explained the experimenter's reasoning.

Teaching students to detect semantic ambiguity has also been found to support students' metalinguistic and metacognitive awareness (Zipke et al., 2009). Zipke and colleagues found that third-grade students who received metalinguistic ambiguity instruction focused on analyzing multiple meaning words (e.g., watch) and sentences (e.g., The ball was found by the kitten) in isolation, in riddles, and in texts were better able to provide multiple definitions of ambiguous words and explain double meanings of ambiguous sentences than students who did not receive this instruction.

Studies have also found that direct instruction of metalinguistic and metacognitive strategies is beneficial for word learning (e.g., Boulware-Gooden et al., 2007; Lubliner & Smetana, 2005). For example, Lubliner and Smetana (2005) investigated the effects of a

multifaceted, metacognitive vocabulary intervention on fifth-grade students' vocabulary achievement. The intervention focused on teaching self-monitoring and self-regulation, with the goal of helping students learn to monitor their understanding of words and internalize and implement word-learning strategies to support reading comprehension. Students were taught the metacognitive strategies of looking for context clues, substituting a familiar synonym for an unfamiliar word, using familiar roots and affixes to determine a word's meaning, considering if the word sounds familiar and trying to remember its meaning, asking someone the meaning of a word, and marking where an unfamiliar word is encountered in order to follow up on its meaning at a later time. Students were also taught to monitor and rank their level of knowledge for a word, from unknown to partially known to fully known. Lubliner and Smetana found that students were better able to self-monitor their word knowledge and made significant gains in vocabulary acquisition with the intervention compared to business-as-usual instruction. Further, in a between-subjects comparison of students in a Title I school receiving the intervention and students in an "above-average-performing school" (p. 163) receiving business-as-usual vocabulary instruction, the significant difference in vocabulary acquisition between these groups prior to the intervention was no longer significant following the intervention. Likewise, Boulware-Gooden et al. (2007) examined the effectiveness of systematic direct instruction of metacognitive strategies on third-grade students' vocabulary achievement, finding that students receiving this instruction improved significantly in vocabulary over students in the comparison condition, with a 40% difference in gains in vocabulary between the two groups.

In summary, these studies focused on building students' metalinguistic and metacognitive awareness found that students' word learning was supported when students learned to use contextual and morphemic analysis, explain how word meanings were derived from context,

detect semantic ambiguity, and self-monitor and self-regulate. In the present study, I identified the ways in which teachers used language to build students' awareness of words and word learning that aligned with this research base.

As the literature reviewed here has demonstrated, multifaceted instruction supports oral language and vocabulary development, with students benefiting from approaches that build their knowledge of word meanings, scaffold their word use, and build their awareness of words and word learning. In the present study, I considered how the teachers' talk addressed each of these approaches. In the following section, I present research supporting the integration of this kind of language and literacy instruction with science instruction.

Opportunities for Oral Language and Vocabulary Development in Science Instruction

As noted in Chapter 1, the Next Generation Science Standards (NGSS) emphasize oral language development in the early-elementary grades (NGSS Lead States, 2013). In their content analysis of the NGSS framework document (National Research Council, 2007) and student learning expectations (NGSS Lead States, 2013), Wright and Domke (2019) found that oral language is emphasized as a way to support students' sensemaking and for students to communicate their learning and ideas. Further, they found that the NGSS framework document encourages educators to provide students with opportunities to learn, use, and apply discipline-specific vocabulary during science instruction. Therefore, NGSS-aligned science instruction would provide many opportunities for oral language and vocabulary development (NGSS Lead States, 2013; Wright & Domke, 2019).

Indeed, science instruction has been established as a rich context for oral language and vocabulary development (e.g., Gotwals & Wright, 2017; Wright & Gotwals, 2017; Wright & Neuman, 2014). In their observational study of vocabulary instruction across the school day in

kindergarten classrooms, Wright and Neuman (2014) found that although students received, on average, only 2.5 minutes of science instruction per day, science instruction provided rich opportunities for vocabulary instruction when taught. Specifically, teachers provided explanations of target words or helped students determine target word meanings more times during science instruction, social studies instruction, and interactive read-alouds than during reading and writing instruction, math instruction, or morning meeting. Wright and Gotwals (2017) found that vocabulary learning within science instruction was supported by curriculum materials designed to engage students in disciplinary oral language—or the ways that scientists talk. They created curriculum materials to support kindergarten students' science talk and then conducted a quasi-experimental study to examine students' oral language outcomes. Wright and Gotwals found that students in the intervention condition outperformed students in the business-as-usual comparison condition on measures of receptive science vocabulary and use of vocabulary in a science context.

Research has shown that integrating language and literacy instruction with science instruction is beneficial for both literacy and science learning (e.g., Cervetti et al., 2012; Connor et al., 2017; Gotwals & Wright, 2017, 2017; Guthrie et al., 1999; Romance & Vitale, 1992, 2001; Varelas et al., 2006; Varelas & Pappas, 2006; Vitale & Romance, 2012; Wang & Herman, 2006). For example, Guthrie et al. (1999, 2009) examined the effects of *Concept-Oriented Reading Instruction* (CORI), which integrated supports for reading motivation, oral reading fluency, and reading comprehension within science instruction focused on building students' content knowledge of ecology. They found that fifth-grade students in the CORI intervention condition scored higher on posttest measures of word recognition speed, reading comprehension, and ecological knowledge than students in the comparison condition receiving traditional instruction.

Further, they found that the CORI intervention was equally effective for low- and high-achieving readers (Guthrie et al., 2009). Similarly, Romance and Vitale (2001) found that students in grades 2-5 showed improved science understanding and reading achievement when traditional literacy instruction was replaced with science instruction that encompassed reading comprehension and language arts skills (i.e., *In-Depth Expanded Applications of Science*; IDEAS). Likewise, Wang and Herman, (2006) examined how integrated units in the *Seeds of Science/Roots of Reading* project (Seeds/Roots) impacted the interest, motivation, and learning of students in grades 2-4, finding that students in the Seeds/Roots intervention condition learned significantly more than students in the comparison condition on all science and literacy measures. In a related study, Cervetti et al. (2012) found that fourth-grade students who received integrated science-literacy instruction that engaged students in reading text, writing notes and reports, conducing firsthand investigations, and discussing key concepts and processes made significantly greater gains on measures of science understanding, science vocabulary, and science writing than students receiving science instruction that was not integrated with literacy instruction. Similarly, Connor et al. (2017) found that kindergarten through fourth-grade students receiving *Content-Area Literacy Instruction* (CALI) as an individualized instructional program showed improved science knowledge and oral and reading comprehension skills.

In summary, science instruction offers a rich context for oral language and vocabulary development, and instruction that integrates science and literacy has been shown to effectively promote both science and literacy learning. In the present study, I examined the vocabulary talk moves teachers made within the context of science instruction because, despite the emphasis placed on oral language development by national standards and the research supporting the integration of language and literacy instruction with science instruction, little is known about

how teachers promote oral language and vocabulary development in science instruction in the early-elementary grades.

The Present Study

The purpose of the present study is to examine the ways in which teachers use language to promote oral language and vocabulary development (i.e., vocabulary talk moves) during science instruction in early-elementary classrooms. Science instruction offers a rich context for oral language and vocabulary development and national standards emphasize supporting this development, yet little is known about how teachers promote oral language and vocabulary development within this context in the early-elementary grades. Therefore, I ask the following questions:

1. How do teachers use language to promote students' oral language and vocabulary development during science instruction in early-elementary classrooms?
2. Is vocabulary talk related to the language aspects of science talk, and if so, how?
3. What features of science curriculum materials are related to a kindergarten teacher's enhanced vocabulary talk?

Summary

Oral language and vocabulary development are important for students' overall academic success. Oral language and vocabulary support science learning, while the background knowledge and vocabulary students gain from science learning supports their reading comprehension. Current national standards emphasize the importance of oral language and vocabulary development, beginning in the early-elementary grades. Science instruction offers a rich context for oral language and vocabulary development; however, little is known about how teachers promote oral language and vocabulary development within science instruction in the

early-elementary grades. I seek to address this gap in the literature with this dissertation study. We must first understand the ways in which teachers do and do not promote oral language and vocabulary development during science instruction in the early-elementary grades in order to best support teachers in implementing effective oral language and vocabulary instruction. This is important so that all students are prepared to meet these ambitious standards and, ultimately, develop the oral language and vocabulary needed to strengthen their reading comprehension and support their science learning.

CHAPTER 3—METHODS

Given the importance of oral language and vocabulary development to students' literacy and science learning (e.g., Anderson & Freebody, 1981; Guthrie et al., 1999; Mercer et al., 2004; Richmond & Striley, 1996; Senechal et al., 2006; Wang & Herman, 2006; Wright & Gotwals, 2017), I conducted two instrumental case studies (Barone, 2011; Stake, 2000) to examine teachers' vocabulary talk during science instruction in the early-elementary grades. Together, these instrumental case studies comprise my dissertation study. In the first study, I examined the science instruction of a cohort of eight early-elementary teachers (i.e., teachers of early-elementary students—rather than elementary teachers who are early in their career) in order to determine (1) how they used language to promote students' oral language and vocabulary development and (2) whether vocabulary talk is related to the language aspects of science talk, and if so, how. In the second study, I examined the science instruction of one kindergarten teacher in order to identify features of science curriculum materials related to enhanced vocabulary talk. In this chapter, I describe the methodology used in these studies. First, I provide information about the context of the larger study within which this dissertation was situated. Then, I explain the design and logic, case, data sources, and analytic strategies for each of the studies. Finally, I discuss limitations of the methodology.

Context of Larger Study

The present dissertation study is situated within a larger study of science talk in early-elementary classrooms. The **S**cience, **O**ral Language, and **Li**teracy **D**evelopment from the **Start** of School (SOLID Start) project (PIs: Dr. Tanya Wright & Dr. Amelia Gotwals), funded by the National Science Foundation (NSF; Award Number: 1620580), is focused on supporting K-2 teachers with promoting science talk in their classrooms. This larger study is a 10-week usability

trial of the SOLID Start professional development model with eight early-elementary teachers. With this model, teachers read texts and watch videos related to supporting equitable science participation and engagement, deepening science understanding, and developing language and literacy for science. They meet with other participating teachers and an instructional coach in professional learning communities (PLCs) to discuss these texts and videos and to plan an upcoming science lesson. Teachers learn about the SOLID Start Tool, a formative observational tool that can be used to provide feedback or facilitate self-reflection on talk that promotes sensemaking during science instruction. After teaching a science lesson, teachers use the SOLID Start Tool to reflect on opportunities for science talk and then meet virtually with an instructional coach to debrief the lesson and receive feedback through the lens of the Tool. The focus of this larger study was to gain insight into various aspects of the usability of the professional development model, such as if teachers could video record and upload their own lessons, interact with their instructional coach and other participants using the Zoom online meeting platform, and use the SOLID Start Tool. Because teachers recorded their science instruction as part of the study, this SOLID Start professional development usability trial provided the context for me to study vocabulary talk during science instruction.

Study 1: Vocabulary and Science Talk in Eight Early-Elementary Classrooms

This study addresses two research questions: (1) How do teachers use language to promote students' oral language and vocabulary development during science instruction in early-elementary classrooms? and (2) Is vocabulary talk related to the language aspects of science talk, and if so, how? In the sections that follow, I describe the design and logic, participants, data sources, and analytic strategies used to address these research questions.

Design and Logic

I used an instrumental case study design in order to investigate how teachers use language to promote students' oral language and vocabulary development during science instruction at the early-elementary grades and whether/how vocabulary talk is related to the language aspects of science talk. Instrumental case studies allow researchers to look for insight into an issue (Barone, 2011; Stake, 2000). With this design, the case plays a supporting role by facilitating understanding of the issue of interest. The case, itself, although studied in depth, is of secondary interest to the primary issue. In this first study, the case is the science instruction of the cohort of eight early-elementary teachers who participated in this study from February-May 2019. The issue of primary interest is how the teachers used language to promote oral language and vocabulary development during science instruction. Therefore, I studied the science instruction of the cohort in depth to better understand this issue of primary interest.

Participants

The case examined in this study is the science instruction of a cohort of eight early-elementary teachers: one young 5s teacher, three kindergarten teachers, two first-grade teachers, and two second-grade teachers. All participants identified as White/European American females and taught in the same elementary school in a small district within a large Midwestern state. The teachers had between 0.5-19 years of teaching experience. All eight teachers had a bachelor's degree, and three teachers had also completed master's degrees. At the time of the study, 27.15% of students at the school were eligible for free or reduced-price lunch. Of the 188 students in the eight classrooms, 95.74% identified as White or European American, 1.6% identified a Black or African American, 1.6% identified as biracial or multiethnic, 0.53% identified as Hispanic or Latino/a, and 0.53% identified as Asian or Pacific Islander. No students were learning English as

an additional language. In the following chapter, I introduce the individual teachers who together comprise the case I examined in order to better understand vocabulary talk during science instruction in the early-elementary grades.

Teachers were invited to participate in the SOLID Start professional development usability trial with enrollment on a first come, first-served basis. They were invited to serve as research partners, by (a) participating in a 10-week online professional development focused on supporting talk around equitable science participation and engagement, deepening science understanding, and developing language and literacy for science; (b) uploading three videos of themselves teaching science lessons throughout the course and receiving feedback from a coach on these lessons [this was later adjusted to two videos based on teacher feedback]; and (c) providing feedback on the professional development experience through surveys, interviews, and/or focus groups. Participants received a $500 stipend and 15 State Continuing Education Clock Hours (SCECHs). (See Appendix A for complete recruitment information.)

Data Sources

This study draws on three data sources: a demographic background and teaching experience information survey, weekly instructional logs, and video recordings of participants teaching science lessons. Following, I describe these data sources and the rationale for their use.

Demographic Background and Teaching Experience Information Survey

Each participating teacher completed a survey at the very beginning of the study, providing information on the following: demographics (e.g., age, gender, race/ethnicity), professional experience (e.g., type(s) of teaching degree(s) earned, type of teaching certification, years of teaching experience), professional development (e.g., content areas/topics of recent professional development), setting description (e.g., demographics of students), and science and

literacy instruction (e.g., curriculum materials, instructional minutes per week for language arts instruction and science instruction, confidence with specific instructional practices). (See Appendix B for full survey.) This survey gave me background information about the participating teachers, their students, and aspects of their instruction, which deepened my understanding of the case (i.e., the science instruction of the cohort of participating teachers) from which I examined the issue of interest (i.e. vocabulary talk during science instruction) (Barone, 2011; Stake, 2000).

Weekly Instructional Log

I collected information from participating teachers each week regarding the number of minutes of science instruction they taught each day, the activities within their science lessons (e.g., reading aloud of informational text, watching a video, planning and/or carrying out an investigation), and the science curriculum materials they used. (See Appendix C for full instructional log.) Using a Google Form, I collected this data beginning the week before the professional development started and continuing through Week 10. This log provided further information about the science instruction of the cohort of teachers comprising the case I studied to better understand vocabulary talk during science instruction.

Video Recordings of Science Lessons

As part of the SOLID Start professional development usability trial, each participating teacher's science instruction was video recorded at three points in the professional development: before the professional development experience began (PrePD), during Week 5, and during Week 9. This is consistent with other observational studies that have found analyzing data from three timepoints to be adequate for capturing classroom instruction (e.g., Silverman et al., 2014; Silverman & Crandell, 2010; Wasik & Bond, 2001). For these lessons (and throughout the study

in general), teachers could use any science curriculum or materials they had available to them. A member of the SOLID Start research team recorded the PrePD lesson, and teachers then recorded and uploaded the Week 5 and Week 9 lessons themselves. These 24 lesson videos totaled 894.27 minutes of observational data, with lessons ranging from 13:27 to 1:13:25. As my primary data source, the video recordings captured early-elementary science instruction, enabling me to examine the ways in which the participating teachers used language to promote oral language and vocabulary development (i.e., vocabulary talk) and how this might relate to science talk.

Analytic Strategies

I used both qualitative and quantitative analytic strategies to address my research questions. In the following sections, I detail the analysis methods for each research question.

Research Question 1: How Do Teachers Use Language to Promote Students' Oral Language and Vocabulary Development During Science Instruction in Early-Elementary Classrooms?

Based on Gee's (2014) notion that language is used to carry out specific actions rather than just to give one another information, I used discourse analysis techniques to examine the ways in which teachers used language to promote students' oral language and vocabulary development. In the present study, I added to and refined a codebook for vocabulary talk that I initially developed in a pilot study examining one kindergarten teacher's vocabulary talk during 421.96 minutes of science instruction across 10 video recorded lesson observations. In the following sections, I first describe the how the codebook was initially developed in the pilot study and then describe my analysis in the present study.

Pilot study. In the initial study, I used teacher turns (i.e., everything the teacher said until another person spoke) as my unit of analysis, and I used two levels of codes. The first-level codes were provisional codes (Miles et al., 2014; Saldaña, 2016) derived from the literature on

how children learn words (as reviewed in Chapter 2). Based on vocabulary instruction research, the KNOWLEDGE & UNDERSTANDING code captured talk that builds knowledge of word meanings, the STUDENT WORD USE code captured talk that scaffolds students' word use, and the METALINGUISTIC & METACOGNITIVE AWARENESS code captured talk that builds students' awareness of words and word learning. Finally, based on the theory of word consciousness (e.g., Anderson & Nagy, 1992; Graves & Watts-Taffe, 2002, 2008), the AFFECTIVE FACTORS code captured talk that interested students in words and word learning. I refer to these first-level codes as *types of vocabulary talk*.

The second-level codes identified the specific vocabulary talk moves the teacher made within each type of vocabulary talk (i.e., first-level codes). Using pattern coding (Miles et al., 2014; Saldaña, 2016), I focused on one type of vocabulary talk at a time (e.g., building knowledge of word meanings, as captured by the first-level code KNOWLEDGE & UNDERSTANDING) but repeated this process for each type of vocabulary talk. First, I wrote descriptions of the teacher's turns, summarizing what the teacher said and naming what she *did* through language. Through an iterative process, I read teacher turns, wrote descriptions, noticed patterns in descriptions, wrote new descriptions to capture these patterns, reread teacher turns, and refined descriptions. Through these descriptions, I identified the specific vocabulary talk moves the teacher made within each of the four types of vocabulary talk. For example, explaining or defining the meaning of a word was a vocabulary talk move the teacher made (i.e., second-level code EXPLAIN/DEFINE) within vocabulary talk that builds knowledge of word meanings (i.e., first-level code KNOWLEDGE & UNDERSTANDING). In total, during this initial study, I found 24 different vocabulary talk moves that the teacher made within the four types of vocabulary talk. The initial codebook I established during the pilot study provided the

provisional codes (Miles et al., 2014; Saldaña, 2016) (first- and second-level codes) for the present student.

Present study. In the present study, I used teacher utterances as my unit of analysis rather than teacher turns. I found in my pilot study that the kindergarten teacher's turns were often quite long and involved a number of different vocabulary talk moves. In fact, I found that the teacher often used a vocabulary talk move more than once within a turn; however, because each second-level code could only be applied once to a turn, this repeated use of vocabulary talk moves within a turn was not captured. Silverman et al. (2014) also encountered this issue when selecting their unit of analysis for their observational study of vocabulary instruction in third-, fourth-, and fifth-grade reading/language arts lessons. They discovered that several different types of instruction often occurred within a turn and that "coding at the level of the turn appeared to mask the full extent to which teachers provided specific types of instruction" (p. 37). Instead, Silverman and colleauges moved to the level of utterance as the unit of anlaysis in order to "reveal a more comprehensive and cumulative picture of the teachers' insructional focus" (p. 37). Likewise, for the present study I moved to the level of utterance as my unit of analysis for a finer-grain examination of vocabulary talk. Selecting utterance as the unit of analysis is consistent with other observational studies that have examined teacher talk in relation to children's vocabulary learning (e.g., Barnes et al., 2017; Barnes & Dickinson, 2017a, 2017b, 2018; E. P. Bowers & Vasilyeva, 2011; Neugebauer et al., 2017; Silverman et al., 2014). I defined an *utterance* as a unit of speech with only one speaker (i.e., bound by conversational turns) and one main clause (subject-predicate) (MacWhinney, 2000; Neugebauer et al., 2017; Rex & Schiller, 2009). As a *conversational unit* (c-unit), an utterance could have dependent (i.e., subordinate or coordinate) clauses in addition to the main clause but could not have more than

one main clause (MacWhinney, 2000). In addition to syntax, I also paid close attention to intonation contours, so that speech tacked on after terminal intonation (i.e., rising for a question or falling for a statement) was transcribed as a new utterance (Ratner & Brundage, 2018).

I first viewed all 24 videos (three videos each for eight participants) and marked *vocabulary talk episodes*—or episodes of instruction that included at least one of the four types of vocabulary talk: building knowledge of word meanings, scaffolding students' word use, increasing awareness of words and words learning, or interesting students in words and word learning. After identifying vocabulary talk episodes, I began the process of transcribing these episodes for analysis. Within each vocabulary talk episode, the teacher's speech was transcribed at the level of utterance, but because student talk was captured to provide context for teacher utterances but would not be coded, student talk was transcribed less formally. Student speech was captured at the level of the turn when possible. When multiple students spoke at the same time, as much of what students were saying was transcribed as possible, but this talk was not always attributed to different speakers. For example, when responding to a teacher's question about what colors clouds can be, multiple kindergarten students called out answers at the same time. These responses were recorded together:

Child(ren): black, gray, gray, black, purple.

As this example shows, student talk was identified collectively as *child(ren*); that is, individual children were not identified. Similarly, utterances in which teachers read text aloud were transcribed to provide context but were not coded, which is consistent with other studies that have examined teacher talk that includes reading text aloud to students (e.g., Barnes et al., 2017). Finally, because teacher utterances were sometimes accompanied by an action or visual cue, comments explaining relevant nonverbal context were included in the transcripts. For example,

the comment *teacher begins by moving her finger and hand haphazardly but then transitions to spinning it vigorously in a circle* accompanied the utterance "instead of the wind moving every which way, it spins in a circle." It was also noted when teachers drew students' attention to specific words or word meanings by emphasizing them. (See Appendix D for full transcription guide.)

An undergraduate research assistant who had been trained on the transcription conventions assisted me with transcribing the vocabulary talk episodes of the 24 videos. After the research assistant completed initial transcripts, I created final transcripts by reviewing the videos next to the initial transcripts and making adjustments as needed, such as by correcting mis-heard words, adding comments to describe relevant nonverbal cues, and noting emphasis.

Following transcription, I completed two cycles of analysis to code the teachers' vocabulary talk during science instruction. In the first cycle, I read the transcripts and applied the provisional codes (Miles et al., 2014; Saldaña, 2016) from my pilot study. As in the initial study, I used two levels of codes. The first level again identified the four types of vocabulary talk (defined in the same way): KNOWLEDGE & UNDERSTANDING, STUDENT WORD USE, METALINGUISTIC & METACOGNITIVE AWARENESS, or AFFECTIVE FACTORS. The second level again identified the specific vocabulary talk move the teacher made. For example, the utterance "it means dangerous" was coded at the first level with KNOWLEDGE & UNDERSTANDING as the general type of vocabulary talk and at the second level with EXPLAIN/DEFINE as the specific vocabulary talk move. For utterances addressing multiple types of vocabulary talk and/or multiple vocabulary talk moves, I applied each relevant code. This is consistent with Gee's (2014) assertion that speakers often simultaneously carry out multiple actions with any one utterance. (See Appendix E for full Vocabulary Talk Codebook.)

In the second cycle of coding, I examined teacher utterances that addressed at least one type of vocabulary talk (i.e., first-level codes) but did not fit any of the specific vocabulary talk moves (i.e., second-level codes) identified in the pilot study. In other words, this cycle of coding focused on identifying additional vocabulary talk moves beyond those identified in the pilot study. After applying the appropriate first-level provisional codes to identify type of vocabulary talk, I once again used pattern coding (Miles et al., 2014; Saldaña, 2016) to describe the specific vocabulary talk moves the teachers made. Focusing on one of the four types of vocabulary talk at a time, I wrote descriptions of the teachers' utterances, summarizing what the teachers said and naming what they *did* through language (Gee, 2014). For example, I applied the first-level code STUDENT WORD USE to the utterance "does anyone know the science word when you kind of blend into your environment?" and then wrote the description *teacher asks students if anyone knows the word for what was being described*. After writing descriptions such as this, I (re)read teacher utterances, identified patterns across utterances, and revised descriptions to capture these patterns until I was able to name the specific vocabulary talk move. Returning to the previous example, I named the vocabulary talk move (i.e., second-level code) ELICIT NEW WORD FROM STUDENTS and added the final description to the Vocabulary Talk Codebook: *Teacher asks students for a word that has not been introduced/discussed.* After adding these new vocabulary talk moves to the codebook, I reread all the teacher utterances and applied these new second-level codes as appropriate.

During these two cycles of coding, I also established relationships between the second-level codes (see Table 1). Because repeated exposures to words in multiple contexts supports children with learning words (e.g., Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; McKeown et al., 1983, 1985; McKeown & Beck, 2003; National

Institute of Child Health and Human Development, 2000; Robbins & Ehri, 1994; Silverman, 2007a, 2007b; Silverman & Crandell, 2010; Stahl & Fairbanks, 1986; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014), it was important to capture teachers' use of words that had been targeted for instruction (i.e., USE TARGET WORD). However, in order to determine which words were target words, I had to first determine which vocabulary talk moves established a word as a target word. I defined a *target word* as a word related to science learning that the teacher seemingly targeted for instruction by bringing students' awareness to the word and its meaning, such as by explaining or defining a word, acting out or demonstrating the meaning of a word, or eliciting students' ideas about what a word meant (either a word being reviewed or a new word being introduced). I considered these vocabulary talk moves that are focused on bringing students' awareness to a word and its meaning to be codes for *Identifying Target Words*. Because I was examining teacher talk within the context of science instruction, a majority of the words teachers explained/defined, for example, were related to science learning. However, there were a few exceptions when the teacher used one of the *Identifying Target Words* vocabulary talk moves for a word unrelated to science learning. In these rare cases, the utterance was still coded with the vocabulary talk move but was not considered to become a target word. For example, in one lesson, a kindergarten student talked about tornadoes being harmful enough to lift the Hancock Building in Chicago, and another student asked, "What's a Hancock?" The teacher explained, "It's a famous building, a really big, tall skyscraper." This utterance was coded with the first-level code KNOWLEDGE & UNDERSTANDING and the second-level code EXPLAIN/DEFINE, as well as the first-level code AFFECTIVE FACTORS and the second-level code ANSWER A QUESTION; however, the term *Hancock Building* did not become a target word. In this case, the teacher was responding to a student's question rather than

targeting the word for instruction. The word was not related to science learning within this weather-focused lesson and was not used or discussed again at any other point in the lesson.

It is important to note that my use of the term *target word* differs from many of the studies reviewed in Chapter 2 (e.g., Beck & McKeown, 2007; Biemiller & Boote, 2006; Coyne et al., 2009; Silverman, 2007a). Many of those were intervention studies designed to teach students the meaning of specific words; to determine the intervention's effectiveness, students were tested on those words before and after the intervention. In my observational study, I did not target words for instruction; rather, I was interested in capturing words the teachers seemingly targeted for instruction by bringing students' awareness to the word and its meaning—whether this was with a planned set of science words or with words related to science learning that were explained more spontaneously. This is consistent with Wright and Neuman's (2014) observational study of vocabulary instruction across the school day in kindergarten classrooms, in which target words were identified from *vocabulary episodes*—or interactions in which the teacher (a) provided the meaning of a target word, including child-friendly definitions, synonyms, antonyms, category membership, examples; or (b) or helped students determine the meaning of a target word, such as by eliciting students' explanations.

After determining which vocabulary talk moves identified a word as a target word, I then determined which vocabulary talk moves were *Affiliated with Target Words*, meaning these second-level codes were only applied to teacher utterances relating to established targeted words. Examples of these vocabulary talk moves include using a target word, drawing attention to a target word by emphasizing it and/or its meaning, and helping students make personal connections to a target word. Finally, I noted which vocabulary talk moves were unaffiliated with target words, meaning they could be applied to teacher utterances that related target words

but they could also be applied to teacher utterances unrelated to target words. Examples of these vocabulary talk moves include suggesting another way to say something, highlighting a word from another domain, and answering students' questions about the meaning of a word.

Table 1

Relationships of Vocabulary Talk Moves to Target Words

Category	Vocabulary Talk Move
Identifying Target Words	Act Out/Demonstrate
	Ask if Heard of Word
	Ask to Repeat
	Differentiate Meaning
	Elicit New Word from Students
	Elicit Student Ideas: Act Out
	Elicit Student Ideas: Example/Nonexample
	Elicit Student Ideas: New Word
	Elicit Student Ideas: Review Word
	Elicit Student Ideas: Synonym
	Explain/Define
	Introduce Word
	Review Word
	Use with Hint
	Prompt Word
	Provide Example/Nonexample
	Provide Visual Support
Affiliated with Target Words	Emphasize
	Elicit Student Questions: Target Word
	Help Students Make Personal Connection
	Use Target Word
	Visually Display Word
Unaffiliated with Target Words	Acknowledge Student Ownership
	Answer a Question
	Appreciate Word/Word Choice
	Comment on Spelling
	Encourage to Use Later
	Highlight Favorite Words
	Highlight Words Across Domains
	Offer Alternative
	Praise
	Restate Differently
	Revoice
	Suggest Word/Phrase

Once all of the specific vocabulary talk moves had been identified and the vocabulary talk episodes had been coded, I selected excerpts of transcripts that provided illustrative examples for specific vocabulary talk moves to share within Chapter 4. When highlighting vocabulary talk moves that often co-occurred, I selected excerpts of transcripts that showed this co-occurrence. When highlighting an individual vocabulary talk move, I looked for places in lesson transcripts where there was density for that particular code so that several different examples of the move could be shown within the span of several utterances. Finally, when more than one excerpt offered multiple examples of the vocabulary talk move(s) being highlighted, I chose an excerpt that had not yet been selected in order to provide a wide range of examples from across the cohort.

I then took a more quantitative look, using descriptive statistics, to understand the frequency with which each broad type of vocabulary talk and each specific vocabulary talk move were used. I summed the number of applications of each of the first-level codes (i.e., type of vocabulary talk) and each of the second-level codes (i.e., specific vocabulary talk move). I then calculated the percentage of the whole for each first-level code and each second-level code.

Finally, I made within- and between-teacher comparisons of vocabulary talk over the course of the study. For within-teacher comparisons, I calculated the percentage of vocabulary talk code applications that addressed each first-level code (i.e., type of vocabulary talk) within each lesson for each teacher. This allowed me to compare individual teachers' use of each type of vocabulary talk across the three timepoints. I then created charts to show each teachers' use of the four types of vocabulary talk within each of the three video recorded lessons. For between-teacher comparisons, I calculated the rate each type of vocabulary talk occurred within each lesson (i.e., total count for each first-level code divided by lesson length in minutes). This was

important because lesson lengths varied within and between teachers; therefore, to be able to compare the frequency of each type of vocabulary talk across lessons, rate per minute was used. Keep in mind that utterances often included more than one vocabulary talk move (i.e., second-level codes). For example, the following utterance includes six different vocabulary talk moves:

> Ms. Thompson: and what do we do at school to prepare, or get ready, in case there's a tornado?
> *teacher holds up the whiteboard with "prepare" written on it; teacher emphasizes "prepare"*

This utterance was coded with five different KNOWLEDGE & UNDERSTANDING vocabulary talk moves (i.e., USE TARGET WORD, EMPHASIZE, USE WITH HINT, VISUALLY DISPLAY WORD, and ELICIT STUDENT IDEAS: EXAMPLE/NONEXAMPLE) and one AFFECTIVE FACTORS move (i.e., HELP STUDENTS MAKE PERSONAL CONNECTION). Therefore, this utterance contributed five code applications to the total KNOWLEDGE & UNDERSTANDING count and one to the total AFFECTIVE FACTORS count. After calculating the total rate per minute for each of the four types of vocabulary talk for each lesson, I graphed each teacher's vocabulary talk over the course of the study.

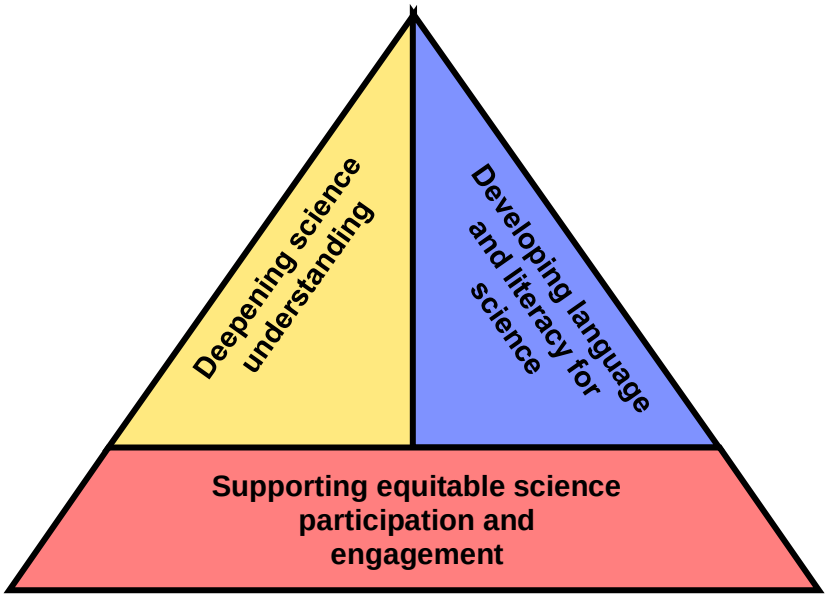
Research Question 2: Is Vocabulary Talk Related to the Language Aspects of Science Talk, and if so, How?

To examine the relationship between vocabulary talk and the language aspects of science talk, I compared the overall trend of each teacher's vocabulary talk with the overall trend of each teacher's science talk related to language learning. For vocabulary talk trends, I used the graphs I created for the between-teacher comparisons of vocabulary talk over the course of the study described for Research Question 1 in the previous section. Using rate per minute, these graphs show how frequently each teacher used each type of vocabulary talk for each of the three video recorded lessons.

For the language aspects of science talk, the SOLID Start Tool (Wright et al., 2017) was used to code the science talk within each of the 24 video recorded science lessons. The purpose of this formative observation tool is to support K-2 educators in promoting sensemaking talk in their science instruction. Specifically, this *science talk* is academically productive (Michaels & O'Connor, 2012, 2015), rigorous, and responsive—providing opportunities for students to "think and talk like scientists" as they work to figure out a science phenomenon. The SOLID Start Tool has three domains (see Figure 1) with three components each. The focus of my analysis was on the final domain: talk that develops language and literacy for science. The three components of this domain are (1) providing contextualized, child-friendly supports for science oral language, (2) scaffolding student use of science oral language, and (3) explicitly supporting disciplinary literacy. I focused specifically on the first two components with this analysis, as they speak to the language aspects of science talk and best align with promoting students' oral language and vocabulary development.

Figure 1

Domains of Science Talk



Note: Domains of science talk in the SOLID Start Tool

Each component of the SOLID Start Tool is scored on a five-point scale, from Low (1) to High (5). The scores of 1, 3, or 5 are assigned when the evidence for the component matches the description for Low, Medium, or High, respectively. (See Table 2 for descriptions.) The score of 2 is assigned when (a) the evidence matches some of both the Low and Medium descriptions or (b) most of the evidence matches the Low description but there is also (minimal) evidence matching the High description. Likewise, the score of 4 is assigned when (a) the evidence matches some of both the Medium and High descriptions or (b) most of the evidence matches the High description but there is also (minimal) evidence matching the Low description. Each activity within a science lesson is scored separately on each component of the SOLID Start Tool. Typical lesson activities include discussions of content, planning discussions for science investigations, discussions during investigations, text-based discussions, video-based discussions, and review/summary/share out discussions.

Table 2

SOLID Start Tool: Domain 3, Components 1-2

	5 (High)	4	3 (Medium)	2	1 (Low)
Component 1	**Contextualized, Child-Friendly Supports for Science Oral Language:** Teacher introduces or reviews science oral language at times when this is appropriate to support students' engagement and participation in science learning. New words or phrases are introduced in child-friendly ways (e.g., by showing images or by explaining the word using language that is already familiar to children) as children engage in science practices.		**Decontextualized Supports for Science Oral Language:** Teacher introduces or reviews science language, but it is out of context from children's science learning (e.g., teacher previews all of the vocabulary for the unit or teacher puts all of the unit vocabulary on a word wall before the unit begins) or teacher introduces science language in ways that are too complex for young children.		**Science Oral Language Not Taught:** Teacher may use scientific oral language but does not introduce or teach this language to students.

Table 2 (cont'd)

Component 2	**Students Use Science Oral Language:** Teacher scaffolds students' use of discipline-specific oral language that has been previously introduced with a focus on discussing students' ideas and engaging in science practices.	**Students Demonstrate Knowledge of Science Oral Language:** Teacher scaffolds student talk about the meaning of science words but students do not have opportunities to use these words to discuss ideas or engage in science practices.	**Science Oral Language Not Used:** Teacher does not expect students to use science oral language.

The SOLID Start Tool was used to score each of the lesson activities from each of the three video recorded lessons for each participant. All 24 lessons were double coded to ensure reliability. Coders met to compare scores and resolved differences in codes. Because the amount of time spent on each activity varied, scores were weighted. To weigh scores, the proportion of the total lesson time was calculated for each activity within a lesson. For example, with a 20-minute lesson, the proportion for a 5-minute activity (Activity 1) would be 0.25 and for a 15-minute activity (Activity 2) would be 0.75. The proportion for each activity was then multiplied by the score for each component within the activity. (See Table 3 for an example. Note that Activity 1 scores were multiplied by 0.25 and Activity 2 scores were multiplied by 0.75.)

Because the number of activities within a lesson also varied, a composite score was calculated for each component so that lessons as a whole could be compared within and across teachers. To reach a composite score, the weighted scores for each activity were summed. In the Table 3 example, Activity 1 scored a 5 (High) for Component 2; however, because this was only 25% of the lesson, the weighed score is much lower. The overall composite score of 2 for Component 2 reflects the fact that 75% of the lesson scored a 1 (Low). All scores—original activity scores, activity weighted scores, and composite scores—ranged from 1-5.

Table 3

Sample Weighted and Composite Scores for a 20-Minute Lesson with Two Activities

	Activity 1 Score	Activity 1 Weighted Score	Activity 2 Score	Activity 2 Weighted Score	Composite Score
Component 1	4	1	5	3.75	4.75
Component 2	5	1.25	1	0.75	2

Finally, after calculating composite scores for each teacher's lessons, I graphed each teacher's science talk related to language learning (i.e., Components 1-2) over the course of the study. I then compared each teacher's vocabulary talk graph with her science talk graph. Because vocabulary talk and science talk were measured on different scales, I looked at overall trends between the two graphs.

Study 2: Curricular Features and Vocabulary Talk in a Kindergarten Classroom

This study investigates features of science curriculum materials related to the enhanced vocabulary talk of one kindergarten teacher. In the sections that follow, I describe the design and logic, participant, data sources, and analytic strategies used to address this research question.

Design and Logic

Once again, I used an instrumental case study design (Barone, 2011; Stake, 2000) in order to look for insight into an issue of primary interest. In this study, my case was the science instruction of one kindergarten teacher, Ms. Thompson, from February-May 2019. Ms. Thompson participated in the larger SOLID Start professional development usability study and was part of the cohort of eight teachers who comprised the case I examined in Study 1. I selected Ms. Thompson's science instruction for further analysis regarding curriculum materials for two reasons. First, I wanted to examine within-subject differences in vocabulary talk (i.e., variance in talk by a single teacher), and Ms. Thompson's vocabulary talk varied noticeably across the three

lessons (see Figure 12 in Chapter 4). Examining differences in one teacher's talk across lessons rather than examining variance in talk from one teacher to another (i.e., between-subjects differences) allowed me to investigate factors impacting vocabulary talk that were outside of just individual differences in speaking patterns or ways of using language. Second, I wanted to compare a teacher's talk from lessons drawing from different sets of curriculum materials, and Ms. Thompson taught from three different sets of materials across the three recorded lessons. Only one other teacher, Ms. Henderson, taught from three different sets of curricular materials. As a young 5s teacher, however, Ms. Henderson did not have grade-level curricular materials. Instead, she adapted lessons from a variety of sources (e.g., *STEM into Nature* professional development by the Academy of Natural Resources, *Dancing with Dinosaurs* program from the Natural History Museum at the University of Michigan, and *Project WILD*), along with designing her own lessons. Because I did not have access to all of these sources, I did not select Ms. Henderson's science instruction for this analysis. Five of the eight teachers taught only from the *Mystery Science/Mystery Doug* materials for their three recorded lessons, and Ms. Nelson taught one lesson based on a *SOLID Start* unit and then taught two lessons from *Mystery Science/Mystery Doug* materials. Because Ms. Thompson taught from *SOLID Start* and *Mystery Science/Mystery Doug materials*— as well as a lesson from *Teachers Pay Teachers*, I selected Ms. Thompson's science instruction for further analysis. Therefore, in this study, I examined Ms. Thompson's science instruction (i.e., the case) in depth in order to better understand the issue of interest: features of the science curriculum materials related to enhanced vocabulary talk during science instruction.

Participant

Ms. Thompson has a bachelor's degree in elementary education with science and English minors and has completed the coursework for a master's degree in teaching natural science—with the exception of the final project. Ms. Thompson's state professional teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom), science (6-8), and English (6-8). Ms. Thompson had 21 kindergarten students in her class, with 95.24% of students identifying as White or European American and 4.76% identifying as Black or African American. At the time of the study, Ms. Thompson had taught kindergarten students for 8 of her 12 years of teaching experience. She taught an average of 49.91 minutes of science instruction per week during the course of this study, with weekly totals ranging from 9-90 minutes. She reported 36 days with science instruction during the study, with an average of 3.27 days with science instruction per week. Ms. Thompson reported using *SOLID Start* and *Mystery Science* curriculum materials, along with supplemental materials from *Teachers Pay Teachers* and apps such as *Nico and Nor* and *Seesaw*.

Data Sources

In addition to the demographic background and teaching experience information survey, the weekly instructional log, and the video recordings of science lesson described in Study 1, I also collected science curriculum materials for the three lessons Ms. Thompson taught. The first lesson was *How Can We Prepare for Severe Weather?* (Lesson 7) from the *SOLID Start* Weather Forecasting unit (Gotwals & Wright, 2017; Wright & Gotwals, 2017). While providing curriculum materials was not part of the SOLID Start professional development usability study, Ms. Thompson had participated in a pilot study of the *SOLID Start* kindergarten curriculum the previous school year and had access to these materials. Participants in the usability study could

use any curriculum available to them, and Ms. Thompson chose to use this lesson from the *SOLID Start* curriculum for her PrePD lesson. The second lesson (i.e., Week 5) was from a *Teachers Pay Teachers* packet on force and motion. The third lesson (i.e., Week 9) was *Where Do Animals Live?* (Lesson 2) from the *Mystery Science* Plant and Animal Secrets unit (Schacht & Peltz, 2020). (See Chapter 5 for a description of each lesson as presented by the curriculum materials.) These three lessons from three different sets of curriculum materials helped me to examine curricular features related to enhanced vocabulary talk.

Analytic Strategies

I began this qualitative analysis by carefully reading through the coded transcripts of Ms. Thompson's enacted lessons and identifying places with dense vocabulary talk, meaning that multiple vocabulary moves were made over a span of utterances. This was important because, in order to examine the relationship between Ms. Thompson's enhanced vocabulary talk and science curriculum materials, I first needed to identify *enhanced vocabulary talk*. I considered density of vocabulary talk to be evidence of *enhanced vocabulary talk*, as Ms. Thompson engaged in sustained vocabulary talk (i.e., over the span of multiple utterances) using multiple vocabulary talk moves in these places. I also highlighted words that had been identified as target words in my Study 1 analysis (i.e., words related to science learning that Ms. Thompson seemingly targeted for instruction by bringing students' awareness to the words and their meaning) and noted the teachers' questions/prompts related to these target words. After this initial analysis of Ms. Thompson's enacted lessons, I carefully read/viewed the written lessons as presented in the *SOLID Start, Teachers Pay Teachers*, and *Mystery Science* curriculum materials. For each of the areas of dense vocabulary talk I had identified in the enacted lessons, I examined the written lessons to see if there was anything in the curriculum materials seemingly

related to this talk. I noted places in which specific vocabulary words were targeted for instruction (if any) and noted what supports were provided for introducing and/or reviewing these words (if any). I compared the list of vocabulary words targeted for instruction by the curriculum materials (if any) to the list of words targeted for instruction in Ms. Thompson's enacted lessons. Throughout this analysis, as I found curricular features (e.g., targeted vocabulary words) that seemed to be related to enhanced vocabulary talk in one lesson, I looked for this relationship across the other two written/enacted lessons as well.

Finally, I selected excerpts of transcripts to share within Chapter 5 to highlight curricular features related to enhanced vocabulary talk. I looked across all three lessons for illustrative examples of enhanced vocabulary talk related to each curricular feature I identified. For example, I selected an excerpt each from Ms. Thompson's *SOLID Start* and *Mystery Science* lessons to show the relationship between text selection and vocabulary talk. In this case, the *Teachers Pay Teachers* lesson did not include text, so I did not select an example of Ms. Thompson's vocabulary talk from this lesson for this feature.

Researcher Positionality

My analysis in this dissertation study has been influenced by my experiences as a classroom teacher and research assistant. As a former early-elementary classroom teacher, I drew from my own teaching experience—in addition to the literature on how children learn words—when identifying vocabulary talk moves and analyzing features of science curriculum materials. For example, when identifying words that teachers targeted for instruction on their own, I considered the ways in which I drew students' attention to new words and their meanings in my own teaching, such as by asking students to say to repeat the target word while introducing it and its meaning—which is also supported by the literature (e.g., Beck & McKeown, 2007; Coyne et

al., 2010; Rosenthal & Ehri, 2011; Silverman & Crandell, 2010). As a research assistant for the SOLID Start project for four years, I have collaborated with the team on curriculum development, SOLID Start Tool development, and the development and coordination of the professional development usability trial. Together, these experiences as a research assistant on the SOLID Start project shaped how I thought about the language aspects of science talk when considering how this relates to vocabulary talk and how I thought about curricular features when analyzing features related to enhanced vocabulary talk.

Limitations to the Method

There are several limitations to the methodology of this dissertation study. First, this study took place within the context of a larger study providing teachers with professional development on engaging students in science talk, so while vocabulary talk was not a focus of the professional development experience, this observational study did not take place within the context of business-as-usual science instruction. Given that very little time is devoted to science instruction at the elementary level (Berliner, 2011; Blank, 2012), it was important to find early-elementary teachers who would be teaching science lessons on a regular basis. The teachers participating in the SOLID Start professional development committed to teaching and recording their science lessons at three points, which provided me with the context in which to examine vocabulary talk during science instruction. Further, while the language aspects of science talk were touched on during the part of the professional development focused on talk that supports language and literacy for science, vocabulary talk was not a focus of the overall professional development.

The second limitation is that only eight teachers were included in this observational study. Many observational studies of vocabulary instruction include a larger number of teachers

(e.g., Carlisle et al., 2013 [*n*=44]; Nelson et al., 2015 [*n*=107-119 over three years]; Neugebauer et al., 2017 [*n*=27]; Scott et al., 2003 [*n*=23]; Silverman & Crandell, 2010 [*n*=16]; Wanzek, 2014 [*n*=14]; Wright & Neuman, 2014 [*n*=55]). However, Watts (1995) examined the instruction of six teachers and Dickinson et al. (2008) examined the instruction of four teachers. Therefore, there is a precedent for observational studies of vocabulary instruction examining a relatively small number of teachers. Further, like the taxonomy of methods for teaching vocabulary instruction developed by Watts (1995), the present study was focused on identifying specific vocabulary talk moves made by teachers, which was possible to do across the 24 lessons observed from the cohort of eight teachers studied.

A third limitation is that the SOLID Start Tool was under development at the time of the analysis. While the tool has been through several iterations of revisions since these lessons were scored, Components 1-2 of Domain 3 (i.e., the language aspects of science talk) have not changed, and therefore these scores have not changed. Each activity within a lesson was double coded and scorers reconciled any disagreements after discussion.

Finally, perhaps the greatest limitation of the present study is that no student outcome data was collected. While a number of observational studies of vocabulary instruction have not included student outcome data (Blachowicz, 1987; Dickinson et al., 2008; Nelson et al., 2015; Scott et al., 2003; Wanzek, 2014; Watts, 1995; Wright & Neuman, 2014), the absence of this information makes it impossible to confirm that the vocabulary talk moves identified in the present study promote students' oral language and vocabulary development. Therefore, unlike observational studies that found correlations between vocabulary instructional methods and students' learning (e.g., Carlisle et al., 2013; Neugebauer et al., 2017; Silverman & Crandell, 2010), the relationship between the vocabulary talk moves identified in the present study and

students' oral language and vocabulary development have not yet been examined. The vocabulary talk moves identified here are aligned with research suggesting they would promote oral language and vocabulary development, but future research is needed to determine if this is the case.

Summary

Two instrumental case studies comprise this dissertation study. In the first study, the case is the science instruction of a cohort of eight early-elementary teachers and the issue of primary interest is how they used language to promote students' oral language and vocabulary development. In the second study, the case is one kindergarten teacher and the issues of primary interest are the features of science curriculum materials related to enhanced vocabulary talk during science instruction. In total, 24 video recorded science lessons provided 894.27 minutes of observational data across three timepoints from the eight participating teachers. Discourse analysis and other qualitative analysis techniques were used to examine the vocabulary talk moves the teachers made during science instruction. Quantitative techniques were also used to make within- and between-teacher comparisons of vocabulary talk over the course of the study.

Little is known about how teachers promote oral language and vocabulary development in science instruction in the early-elementary grades; therefore, the goal of this dissertation study is to examine the ways in which teachers use language to promote oral language and vocabulary development during science instruction. It is important to understand what opportunities students have to develop oral language and also access science content, as both support literacy *and* science learning.

CHAPTER 4—STUDY 1 FINDINGS: RESEARCH QUESTIONS 1-2

The primary goal of this study was to describe how teachers promote oral language and vocabulary development during science instruction in the early-elementary grades. I report findings based on 894.27 minutes of observational data across 24 total lessons, ranging from 13:27 to 1:13:25, in eight early-elementary classrooms. I investigated the following research questions:

1. How do teachers use language to promote students' oral language and vocabulary development during science instruction in early-elementary classrooms?
2. Is vocabulary talk related to the language aspects of science talk, and if so, how?

In this section, I present findings investigating the vocabulary talk and science talk that occurred during early-elementary science lessons. I begin by introducing the cohort of eight teachers who together comprise the case I examined. Then I present the specific vocabulary talk moves the teachers made within each of the four types of vocabulary talk: *Knowledge & Understanding, Affective Factors, Student Word Use,* and *Metalinguistic & Metacognitive Awareness*. Next I present within- and between-teacher comparisons of vocabulary talk over the course of the study. Finally, I describe the relationship between vocabulary talk and the language aspects of science talk.

When lesson transcripts are shared throughout this chapter and the next, the vocabulary talk moves are printed in bold text in the brackets following teacher utterances, and comments providing additional context are printed in italics below the utterance to which they refer. Also note that (parts of) some transcripts are shared multiple times within Chapter 4 and/or 5, highlighting different aspects of vocabulary talk. For ease of reading, these transcripts are provided within the text again so that navigating back to previous findings is not required.

The Teachers

With an instrumental case study (Barone, 2011; Stake, 2000), it important to study the case in depth in order to understand the issue of primary interest. In this section, I present a description of each of the eight teachers who together comprise the case I examined in order to better understand vocabulary talk during science instruction in the early-elementary grades. These descriptions include self-reported information about education, teacher certification, teaching experience, student demographics, amount and frequency of science instruction, and science curriculum materials used.

Ms. Henderson

Ms. Henderson has a bachelor's degree in elementary education with early childhood, English, and history minors and a master's degree in K-12 literacy. Her state professional teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom), English (6-8), history (6-8), reading specialist (K-12), and early childhood education (PK-K). At the time of the study, Ms. Henderson had 24 young 5s students in her class (i.e., children who will be in kindergarten the following school year), with 95.83% of students identifying as White or European American and 4.17% identifying as biracial or multiethnic. Ms. Henderson had 17 years of teaching experience, with 11 of those years as a young 5s teacher. During the course of the study, she taught an average of 102.18 minutes of science instruction per week, with weekly totals ranging from 30-150 minutes. She reported 31 days with science instruction during the study, with an average of 2.82 days with science instruction per week. As a young 5s teacher without grade-level curriculum, Ms. Henderson drew from a variety of science curriculum materials. She reported using *Growing Up Wild*, *Project Wild*, *Project Learning Tree*, *STEM into Nature* (Academy of Natural Resources professional development for educators), and

her own science curriculum materials. She noted that one of her recorded lessons was mostly original but drew on an activity from the *Dancing with Dinosaurs* program at the University of Michigan's Natural History Museum.

Ms. Thompson

Ms. Thompson has a bachelor's degree in elementary education with science and English minors. She has also completed the coursework for a master's degree in teaching natural science, with the exception of the final project. Ms. Thompson's state professional teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom), science (6-8), and English (6-8). At the time of the study, Ms. Thompson had 21 kindergarten students in her class, with 95.24% of students identifying as White or European American and 4.76% identifying as Black or African American. Ms. Thompson had 12 years of teaching experience, with 8 of those years as a kindergarten teacher. During the course of the study, she taught an average of 49.91 minutes of science instruction per week, with weekly totals ranging from 9-90 minutes. She reported 36 days with science instruction during the study, with an average of 3.27 days with science instruction per week. Ms. Thompson reported using curriculum materials form *SOLID Start*, *Mystery Science*, and *Teachers Pay Teachers*, as well as apps such as *Seesaw* and *Nico and Nor*.

Ms. Nelson

Ms. Nelson has a bachelor's degree in elementary education and child development and a master's degree in early literacy. Her state professional teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom) and early childhood education (PK-K). At the time of the study, Ms. Nelson had 22 kindergarten students in her class, with 90.91% of students identifying as White or European American, 4.55% identifying as

Hispanic or Latino/a, and 4.55% identifying as biracial or multiethnic. Ms. Nelson had 19 years of teaching experience, with 13 of those years as a kindergarten teacher. During the course of the study, Ms. Nelson taught an average of 70 minutes of science instruction per week, with weekly totals ranging from 20-130 minutes. She reported 52 days with science instruction during the study, with an average of 4 days with science instruction per week. Ms. Nelson reported using *SOLID Start* and *Mystery Science/Mystery Doug* curriculum materials.

Ms. Baker

Ms. Baker has a bachelor's degree in elementary education. Her state standard teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom), science (6-7), and social studies (6-8). At the time of the study, Ms. Baker had 22 kindergarten students in her class, with 95.45% of students identifying as White or European American and 4.55% identifying as biracial or multiethnic. Ms. Baker had 5 years of teaching experience, with 2 of those years as a kindergarten teacher. During the course of the study, Ms. Baker taught an average of 81.54 minutes of science instruction per week, with weekly totals ranging from 40-140 minutes. She reported 36 days with science instruction during the study, with an average of 2.77 days with science instruction per week. Ms. Baker reported using *Mystery Science/Mystery Doug* and *Wonderopolis* curriculum materials.

Ms. Watson

Ms. Watson has a bachelor's degree in elementary education. Her state standard teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom). At the time of the study, Ms. Watson had 27 first-grade students in her class, with 96.3% of students identifying as White or European American and 3.7% identifying as Black or African American. Ms. Watson was in her first year of teaching. During the course of the study,

Ms. Watson taught an average of 52.5 minutes of science instruction per week, with weekly totals ranging from 30-60 minutes. She reported 21 days with science instruction during the study, with an average of 1.75 days with science instruction per week. Ms. Watson reported using *Mystery Science* curriculum materials.

Ms. Griffin

Ms. Griffin has a bachelor's degree in elementary education with language arts and math minors. Her state standard teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom). At the time of the study, Ms. Griffin had 27 first-grade students in her class, with 92.59% of students identifying as White or European American, 3.7% identifying as Black or African American, and 3.7% identifying as Asian or Pacific Islander. Ms. Griffin had 2 years of teaching experience and was in her first year as a first-grade teacher. During the course of the study, Ms. Griffin taught an average of 32.27 minutes of science instruction per week, with weekly totals ranging from 0-90 minutes. She reported 12 days with science instruction during the study, with an average of 1.09 days with science instruction per week. Ms. Griffin reported using *Mystery Science* and her own curriculum materials.

Ms. Howard

Ms. Howard has a bachelor's degree in elementary education and a master's degree in curriculum and instruction. Her state professional teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom) and English (6-8). At the time of the study, Ms. Howard had 22 second-grade students in her class, with 100% of students identifying as White or European American. Ms. Howard had 6 years of teaching experience and was in her first year as a second-grade teacher. During the course of the study, Ms. Howard taught an average of 69.09 minutes of science instruction per week, with weekly totals ranging

from 0-185 minutes. She reported 23 days with science instruction during the study, with an average of 2.09 days with science instruction per week. Ms. Howard reported using *Mystery Science* curriculum materials, along with informational texts from the *Reading Street* literacy curriculum.

Ms. Hill

Ms. Hill has a bachelor's degree in elementary education. Her state standard teaching certification is for elementary education (K-5 all subjects, K-8 all subjects self-contained classroom) and early childhood (PK-general and special education). At the time of the study, Ms. Hill had 23 second-grade students in her class, with 100% of students identifying as White or European American. Ms. Hill had 7 years of teaching experience and was in her first year as a second-grade teacher. During the course of the study, Ms. Hill taught an average of 40.42 minutes of science instruction per week, with weekly totals ranging from 0-90 minutes. She reported 12 days with science instruction during the study, with an average of one day with science instruction per week. Ms. Hill reported using *Mystery Science* curriculum materials.

In summary, this cohort of eight teachers participating in the larger SOLID Start professional development usability trial comprised the case I examined in depth in order to better understand how teachers use language to promote oral language and vocabulary development during science instruction in the early-elementary grades. In the sections that follow, I share my findings for each research question.

Research Question 1: How Do Teachers Use Language to Promote Students' Oral Language and Vocabulary Development During Science Instruction in Early-Elementary Classrooms?

To investigate the ways in which teachers use language to promote students' oral language and vocabulary development during science instruction in early-elementary classrooms, I identified the vocabulary talk moves the teachers made that align with the research and theory relative to how children learn words. I found that, collectively, the cohort of teachers used 34 different vocabulary talk moves, as presented in Table 4. This table shows the number of vocabulary talk code applications across the entire data set; that is, Table 4 shows the total number of times each second-level code (i.e., vocabulary talk move) was applied across all eight teachers and all 24 total video recordings. Note that Table 4 is organized with four sections—one for each of the four types of vocabulary talk (i.e., *Knowledge & Understanding, Affective Factors, Student Word Use,* and *Metalinguistic & Metacognitive Awareness*). These four types of vocabulary talk appear in descending frequency of occurrence within the data set. Within each section, specific vocabulary talk moves appear in descending frequency of occurrence within that type of vocabulary talk. To be included in the codebook and analysis, a vocabulary talk move had to be used at least one time across the data set; therefore, provisional codes from the pilot study were removed if they were not applied in the present study. In the following paragraphs, I present examples of specific vocabulary talk moves the teachers used to build knowledge of word meanings, interest students in words and word learning, scaffold students' word use, and increase awareness of words and word learning. For descriptions and examples of all 34 vocabulary talk moves, see the full Vocabulary Talk Codebook in Appendix E.

Table 4

Frequency of Vocabulary Talk Moves

Vocabulary Talk Move	Number of Code Applications (N = 3516)	Percentage of Code Applications
Knowledge & Understanding	**3049**	**86.72%**
Use Target Word	1534	43.63%
Emphasize	354	10.07%
Explain/Define	207	5.89%
Provide Example/Nonexample	167	4.75%
Review Word	124	3.53%
Use with Hint	111	3.16%
Elicit Student Ideas: Review Word	108	3.07%
Visually Display Word	95	2.70%
Introduce Word	89	2.53%
Act Out/Demonstrate	59	1.68%
Elicit Student Ideas: Example/Nonexample	56	1.59%
Provide Visual Support	47	1.34%
Elicit Student Ideas: New Word	36	1.02%
Comment on Spelling	18	0.51%
Elicit Student Ideas: Act Out	16	0.46%
Elicit Student Questions: Target Word	14	0.40%
Elicit Student Ideas: Synonym	8	0.23%
Restate Differently	3	0.09%
Differentiate Meaning	1	0.03%
Highlight Words Across Domains	1	0.03%
Offer Alternative	1	0.03%
Affective Factors	**276**	**7.85%**
Help Students Make Personal Connection	218	6.20%
Praise	29	0.82%
Answer a Question	15	0.43%
Acknowledge Student Ownership	9	0.26%
Appreciate Word/Word Choice	4	0.11%
Highlight Favorite Word	1	0.03%
Student Word Use	**184**	**5.23%**
Prompt Word	113	3.21%
Suggest Word/Phrase	24	0.68%
Revoice	21	0.60%
Ask to Repeat	10	0.28%
Elicit New Word from Students	9	0.26%
Encourage to Use Later	7	0.20%
Metalinguistic & Metacognitive Awareness	**7**	**0.20%**
Ask if Heard of Word	7	0.20%

Knowledge & Understanding

As Table 4 shows, the cohort of teachers used *Knowledge & Understanding* vocabulary talk moves most frequently, accounting for 86.72% of total vocabulary talk code applications. Within this type of vocabulary talk, the teachers used 21 different vocabulary talk moves aligned with the research on building students' knowledge of word meanings. The most frequently-occurring *Knowledge & Understanding* vocabulary talk move was using a target word—or a word that had been targeted for instruction by bringing students' awareness to it and its meaning. Accounting for 43.63% of total vocabulary talk code applications, using a target word was also the most frequently-occurring vocabulary talk move overall—across all four types of vocabulary talk. The second most frequently-occurring *Knowledge & Understanding* vocabulary talk move was emphasizing a target word and/or its meaning. Accounting for 10.07% of total vocabulary talk code applications, emphasizing a target word and/or its meaning was also the second most frequently-occurring vocabulary talk move overall. As using a target word and emphasizing a target word are related vocabulary talk moves, they often were used by teachers together in the same utterance. The following example was selected to show how teachers often emphasized target words as they used them. In this example, Ms. Nelson uses and emphasizes the target word *extreme* multiple times while reviewing it with her kindergarten students:

Ms. Nelson: it was ex-tr-eme. [**Use Target Word, Emphasize**]
teacher emphasizes and draws out "extreme," pausing after each syllable as if each were a clue to the word
Child(ren): extreme!
Ms. Nelson: extreme. [**Use Target Word, Emphasize**]
teacher emphasizes "extreme"
Ms. Nelson: extreme weather. [**Use Target Word, Emphasize**]
teacher emphasizes "extreme"
Ms. Nelson: extreme weather. [**Use Target Word, Emphasize, Visually Display Word**]
teacher writes "extreme weather" on the SMARTBoard and emphasizes "extreme"
Ms. Nelson: we read that book about extreme weather. [**Use Target Word**]

Ms. Nelson: so, so we said so there is different kinds of extreme weather. [**Use Target Word, Emphasize**]
teacher emphasizes "extreme"
Ms. Nelson: what kinds of extreme weather did we talk about? [**Use Target Word, Elicit Student Ideas: Example/Nonexample**]

In this brief exchange, Ms. Nelson provided repeated exposures to the word *extreme*, saying it seven times. She drew attention to it too by saying it with emphasis five of those times. While the word *extreme* was being reviewed at this point in the lesson, Ms. Nelson continued to use the term, as relevant, throughout the lesson. Teachers often used target words repeatedly in a series of utterances while introducing or reviewing them, followed by additional exposures throughout the lesson, as target words related to the discussion.

As shown in Table 4, after using target words and emphasizing target words and/or their meaning, the next most frequently occurring *Knowledge & Understanding* vocabulary talk moves were explaining or defining a word (5.89% of total vocabulary talk code applications) and providing an example or nonexample of a word (4.75% of total vocabulary talk code applications). Teacher utterances were coded for each of these types of vocabulary talk when the teacher provided the explanation/definition or example/nonexample or when the teacher confirmed the accuracy of an explanation/definition or example/nonexample, such as when provided by a student. Code applications for explaining/defining and providing an example/nonexample often appeared together, as teachers frequently followed up an explanation of a word's meaning with examples. The following example was selected to show this co-occurrence. In this example, Ms. Henderson explains the meaning of *needs* and *wants* and provides examples to the young 5s students in her class within a discussion about habitats providing food, water, shelter, and space for inhabitants:

Ms. Henderson: those are our needs. [**Introduce Word, Use Target Word, Emphasize**]
teacher emphasizes "needs"

Ms. Henderson: so the needs are things that we have to have. [**Use Target Word, Emphasize, Explain/Define, Visually Display Word,]**
teacher emphasizes "have to" and places a paper with "needs" written on it in one of the hula hoops
Ms. Henderson: okay?
Ms. Henderson: in order to survive. [**Explain/Define**]
Ms. Henderson: so for example, in our house, do we need to have a way to get water? [**Use Target Word, Emphasize, Help Students Make Personal Connection**]
teacher emphasizes "need"
Child(ren): yes.
Ms. Henderson: yes. [**Provide Example/Nonexample, Help Students Make Personal Connection**]
Ms. Henderson: do we need to have a bed? [**Use Target Word, Emphasize, Help Students Make Personal Connection**]
teacher emphasizes "need"
Child(ren): yes.
Child(ren): to hibernate.
Ms. Henderson: well, to sleep. [**Help Students Make Personal Connection, Revoice**]
Ms. Henderson: but if we have a house, which is our shelter, do we have to have a bed?
teacher emphasizes "have to have" [**Use Target Word, Emphasize, Provide Example/Nonexample, Help Students Make Personal Connection**]
Child(ren): yes.
Ms. Henderson: no. [**Provide Example/Nonexample**]
Ms. Henderson: so a, a bed is a want. [**Introduce Word, Use Target Word, Provide Example/Nonexample, Visually Display Word**]
teacher holds up paper with the word "want" on it as she says the word "want"
Ms. Henderson: a want is something we don't need to survive. [**Use Target Word, Emphasize, Explain/Define**]
teacher emphasizes "don't need"
Ms. Henderson: we don't have to have a bed to survive. [**Emphasize, Provide Example/Nonexample, Help Students Make Personal Connection**]
teacher emphasizes "have to"

In this example, Ms. Henderson paused the discussion about habitats in order to explain the meaning of *needs*. She then engaged students in deeper processing by asking them to determine if water and beds are examples of needs, and she confirmed the accuracy of their responses. (Note that this is slightly different from the *Knowledge & Understanding* vocabulary talk move of eliciting examples/nonexamples from students because, in this instance, students did not generate the examples/nonexamples on their own.) The discussion regarding whether a bed is a need led to the introduction of the word *want*, which Ms. Henderson explicitly explained and

clarified that a bed is an example of a want rather than a need. Within this discussion, Ms. Henderson also indicated that a house is an example of the previously-established target word *shelter*.

The remaining 17 *Knowledge & Understanding* vocabulary talk moves together accounted for 22.38% of total vocabulary talk code applications. For example, teachers used a word in context along with a hint, such as when Ms. Henderson, young 5s teacher, hinted, "So, you will have to design some sort of *crossing* for your animal to get across the road or for, or under the road." Teachers also reviewed the meaning of a word that had already been introduced by eliciting students' ideas, as when Ms. Thompson, kindergarten teacher, asked, "What do we know about *stratus* clouds?" Teachers sometimes acted out or demonstrated the meaning of a word while saying the word. For instance, Ms. Thompson demonstrated pulling something toward herself while explaining, "If someone's pulling something, they're moving it closer to themselves." As a final example, teachers provided a visual support to illustrate the meaning of a word at times, as when Ms. Hill, second-grade teacher, pointed to a photograph of the target word *canyon* and explained, "We get this gap in between and we still have landforms that are really high on either side." (See Appendix E for examples of the full set of *Knowledge & Understanding* vocabulary talk moves.)

In summary, these *Knowledge & Understanding* vocabulary talk moves were aimed at providing students with multiple exposures to target words in a variety of contexts and multiple ways for students to access word meanings, such as by eliciting and/or providing explanations/definitions and examples/nonexamples for target words, acting out the meaning of target words, and showing students an image depicting the target word. Therefore, the teachers used language during science instruction in many ways that are aligned with the research on

building students' knowledge of word meanings. This is important because much of the research examining vocabulary instruction has been within the context of literacy instruction. This finding shows this cohort of early-elementary teachers used many research-based vocabulary practices outside of literacy instruction. While student outcome data was not collected as part of this study, the alignment with research on how children learn words suggests that the cohort of teachers may have promoted students' oral language and vocabulary development with these *Knowledge & Understanding* vocabulary talk moves.

Affective Factors

As Table 4 shows, the cohort of teachers used *Affective Factors* vocabulary talk moves with the second greatest frequency, accounting for 7.85% of total vocabulary talk code applications. Within this type of vocabulary talk, the teachers used six different vocabulary talk moves aligned with the theory and research on interesting students in words and word learning. The most frequently-occurring *Affective Factors* vocabulary talk move was helping students make personal connections, such as by asking students questions about experiences they have had related to a target word, reminding students of a common experience they had that connects to a target word (e.g., connecting recent local weather to the target words *severe* and *extreme*), and asking students to think hypothetically about a target word in the context of their own experiences (e.g., "So, let's pretend our classroom was our habitat" or "What would you need [to wear] for that weather?"). Accounting for 6.20% of total vocabulary talk code applications, connecting to students' personal experiences was the third most frequently-occurring vocabulary talk move overall, across all four types of vocabulary talk. The following illustrative example shows Ms. Henderson helping her young 5s students connect the target words *arrangement, water, food, shelter, space,* and *habitat* to the familiar context of their own classroom:

Ms. Henderson: so *arrangement* is how things are, how things are put next to each other. [**Use Target Word, Explain/Define**]
Ms. Henderson: in our classroom we have an arrangement. [**Use Target Word, Emphasize, Help Students Make Personal Connection**]
teacher points around the room; teacher emphasizes "arrangement"
Ms. Henderson: okay?
Ms. Henderson: our water supply is right there. [**Use Target Word, Help Students Make Personal Connection**]
teacher points off camera
Ms. Henderson: do we have to go down the hall to the office to get water? [**Use Target Word, Help Students Make Personal Connection**]
Child(ren): no.
Ms. Henderson: no. [**Help Students Make Personal Connection**]
Ms. Henderson: our food supply is in our cubby. [**Use Target Word, Help Students Make Personal Connection**]
teacher points in a different direction, off camera
Ms. Henderson: do we have to go all the way outside to get a snack? [**Help Students Make Personal Connection**]
Child(ren): no.
Ms. Henderson: no. [**Help Students Make Personal Connection**]
Ms. Henderson: our shelter is where we're at, right? [**Use Target Word, Emphasize, Help Students Make Personal Connection**]
teacher makes a circle around the room with her pointer finger; teacher emphasizes the word "shelter"
Ms. Henderson: our space is kind of small. [**Use Target Word, Help Students Make Personal Connection**]
Ms. Henderson: but for just being at school we have enough space. [**Use Target Word, Help Students Make Personal Connection**]
Ms. Henderson: and, another part of our arrangement is our bathroom, right? [**Use Target Word, Help Students Make Personal Connection**]
teacher again points in a different direction to something off camera
Ms. Henderson: it's close enough where we don't have to run to the other building to use the restroom. [**Help Students Make Personal Connection**]
Ms. Henderson: so all four of these things, food, water, shelter, and space, have to be in an arrangement for the animals. [**Use Target Word, Emphasize, Visually Display Word, Help Students Make Personal Connection**]
teacher points to the words "food," "water," "shelter," "space," and "arrangement" as she says them; teacher emphasizes "arrangement"

In this example, Ms. Henderson paused a discussion about the features of animal habitats (i.e., food, water, shelter, space—all in an arrangement) in order to help students make personal connections to each of these features. While *food* and *water* are already familiar to five-year-olds, the target words *arrangement*, *space*, and *habitat* are more abstract and therefore more

challenging, especially for young children. By framing the classroom as a habitat and encouraging students to think of *their* food and water supplies, the adequacy of *their* space, *their* shelter, and how everything *they* need is arranged so that *they* do not need to leave the classroom, Ms. Henderson helped students connect to—and likely better understand—these target words. Students may have been more motivated to understand and use these words upon making these connections.

The remaining five *Affective Factors* vocabulary talk moves accounted for only 1.65% of vocabulary talk moves, combined. At times, teachers used the move of praising student word use. For example, Ms. Thompson, kindergarten teacher, responded to the student comment "My prediction is at yellow" by saying, "Oh, I love hearing the word *prediction*." Similarly, Ms. Hill, second-grade teacher, praised a student's word use by saying, "Oh, I liked her description word. Thick." Teachers also used the move of acknowledging students' "ownership" of words by attributing words to the students who used them when sharing their ideas. For example, Ms. Thompson noted, "Myra said there's a *force* happening here," and Ms. Griffin, first-grade teacher, pointed out, "But I also heard Ellis say *curved*." Another move teachers made was to answer students' questions about what words mean or what a word for something is. For example, a kindergarten student asked what a flood was, and Ms. Thompson explained, "A flood is when too much rain falls and there's kind of nowhere for it to go." A second-grade student asked what to call the yellow material (cornmeal) in the investigation, and Ms. Hill responded, "You can call it a landform." Teachers sometimes showed appreciation for a word or word choice encountered within a lesson from a source other than students. For example, in response to *Weather Conditions* as the title of a read-aloud text, Ms. Nelson, kindergarten teacher, exclaimed, "Oooh, that's a fancy word" before inviting students to say *weather conditions* aloud

and explaining the meaning of the term. Finally, the move of highlighting a favorite word was used one time. Ms. Nelson said of *precipitation*, "That is one of my favorite words."

In summary, these *Affective Factors* vocabulary talk moves were aimed at motivating students to use/learn new words, encouraging students' curiosity about word meanings, and modeling appreciation and enjoyment for words and word usage. Therefore, the teachers did use some language during science instruction in ways that are aligned with theory and (limited) research on interesting students in words and word learning. This is notable because of the four types of vocabulary talk, *Affective Factors* has the least empirical support; yet, this cohort of teachers used these vocabulary talk moves more frequently than *Student Word Use* and *Metalinguistic & Metacognitive Awareness* vocabulary talk moves—both of which are well supported in the research literature. It is also important to note that *Affective Factors* vocabulary talk moves accounted for only 7.85% of total vocabulary talk code applications, suggesting that these teachers promoted oral language and vocabulary development in this way at times, but it was not a focus of their vocabulary instruction during science lessons.

Student Word Use

As Table 4 shows, the cohort of teachers used *Student Word Use* vocabulary talk moves third most frequently, accounting for 5.23% of total vocabulary talk code applications. Within this type of vocabulary talk, the teachers used six vocabulary talk moves aligned with the research on scaffolding students' word use. The most frequently-occurring *Student Word Use* vocabulary talk move was prompting students to use a target word that had been previously introduced. This vocabulary talk move accounted for 3.21% of total vocabulary talk code applications. The following example was selected to show how teachers prompted students to use target words. In this example, Ms. Henderson prompts the young 5s students in her class to

use the target word *herbivore* when describing a plant-eating prehistoric creature from a read-aloud text:

Ms. Henderson: was this an herbivore? [**Review Word, Use Target Word, Emphasize**]
teacher emphasizes the word "herbivore"
Ms. Henderson: or a carnivore? [**Use Target Word**]
Ms. Henderson: and how can you tell?
Ms. Henderson: how can you tell?
Ms. Henderson: Hannah?
CHI: carnivore.
Ms. Henderson: it's a carnivore? [**Use Target Word, Emphasize**]
teacher emphasizes the word "carnivore"
Ms. Henderson: what makes you think it was a carnivore? [**Use Target Word, Emphasize**]
teacher emphasizes the word "carnivore"
Child(ren): because it ate plants.
Ms. Henderson: so if it ate plants what was it called? [**Prompt Word**]
Child(ren): um, herbivore.
Ms. Henderson: herbivore. [**Use Target Word, Emphasize**]
teacher emphasizes the word "herbivore"
Ms. Henderson: alright, show me a thumbs up if you agree with Hannah that it's an herbivore (be)cause it ate plants. [**Use Target Word, Emphasize**]
teacher holds up a thumbs up and most students copy her; teacher emphasizes the word "herbivore"
Ms. Henderson: okay, I see a couple thumbs down.
Ms. Henderson: Tripp, tell me why you disagree.
Child(ren): xxx.
Ms. Henderson: okay so it ate plants with its teeth.
Ms. Henderson: and a lot of carnivores have teeth. [**Use Target Word**]
Ms. Henderson: do herbivores have teeth? [**Use Target Word**]
Child(ren): yes.
Ms. Henderson: okay.
Ms. Henderson: so if it has teeth and it's eating a plant, what would it be? [**Prompt Word**]
teacher emphasizes the word "plant"
Child(ren): a herbivore.
Child(ren): a herbivore.
Ms. Henderson: an herbivore. [**Use Target Word, Emphasize**]
teacher emphasizes the word "herbivore"

In this example, the target words *herbivore* and *carnivore* had previously been introduced, but it is evident that there is still some confusion among the young 5s students about which term to use for plant eaters and which to use with meat eaters. While helping students work through this

confusion, Ms. Henderson prompted students to use the target word *herbivore* twice. In other examples of this vocabulary talk move, Ms. Nelson, kindergarten teacher, prompted students to use the target word *cumulonimbus* with the utterance "What type of cloud produces thunderstorms?" and elicited the target word *temperature* with a series of prompts, including "When the meteorologist checks the weather, they talk about precipitation, the clouds, the wind, and the what, Avery?"

The remaining five *Student Word Use* vocabulary talk moves together accounted for only 2.02% of total vocabulary talk code applications. In one move, teachers suggested another way to say something, such as when Ms. Thompson responded to a kindergarten student's idea that fall weather conditions usually include "light wind" by suggesting, "Maybe we could say the word *breezy*?" In a similar move, teachers elevated students' word use by revoicing what a student said in a more academic or conventional way. In one example, a young 5s student explained that the character Bear from the read-aloud text would not be able to live where the character Polar Bear lived "(Be)cause it [Bear] has less wool than him [Polar Bear]" and Ms. Henderson responded by saying, "He has less fur than Polar Bear?" Teachers also used the moved of asking students to repeat (say aloud) a target word, such as when Ms. Henderson introduced the word *sauropod* and asked, "Can you say that word?" At times, teachers elicited a word from students that had not been previously introduced, such as when Ms. Nelson explained to her kindergarten students that the squirrel in the video "kind of blends in a little bit" and then asked, "What do we call that? Does anyone know the science word when you kind of blend into your environment?" At this point, *camouflage* became a target word. Finally, teachers occasionally encouraged students to use target words at a later time—outside of the immediate context in which they were introduced or reviewed. For example, Ms. Hill, second-grade teacher,

wrote the word *insulating*, explaining, “I’m going to put it here because chances are, you are going to use this in your writing later.” Shortly thereafter, she said, “So you will be using this word [insulating] later. That I can promise you.”

In sum, the *Student Word Use* vocabulary talk moves promoted students’ use of target words and provided scaffolds to support their oral language in general. Therefore, the teachers did use some language during science instruction in ways that are aligned with the research on scaffolding students’ word use. However, as these *Student Word Use* vocabulary talk moves accounted for only 5.23% of total vocabulary talk moves, promoting oral language and vocabulary development in this way was not a focus of teachers’ instruction.

Metalinguistic & Metacognitive Awareness

As shown in Table 4, the cohort of teachers used *Metalinguistic & Metacognitive Awareness* vocabulary talk moves least frequently, accounting for only 0.20% of total vocabulary talk code applications. Within this type of talk, the teachers used only one vocabulary talk move aligned with the research on increasing students’ awareness of words and word learning: asking students if they have ever heard of a word. This vocabulary talk move was used very infrequently, appearing only seven times across the 24 recorded lessons. The following example was selected to show how teachers used this move when introducing a new target word. In this example, Ms. Thompson finds out if her kindergarten students are familiar with the new target word *severe*:

> Ms. Thompson: this word says *severe*. [**Introduce Word, Use Target Word, Emphasize, Visually Display Word**]
> *teacher emphasizes the word “severe”*
> Child(ren): severe?
> Ms. Thompson: thumbs up if you've ever heard that word before? [**Ask if Heard of Word**]
> *students give thumbs up*

Ms. Thompson: uh, in the past three, four days, we've had some severe weather conditions. [**Use Target Word, Emphasize, Provide Example/Nonexample, Help Students Make Personal Connection**]
teacher emphasizes the word "severe"
Ms. Thompson: do you agree?
Ms. Thompson: have you heard anybody say that on the news? [**Ask if Heard of Word**]
Ms. Thompson: or your parents use that word? [**Ask if Heard of Word**]
Ms. Thompson: severe? [**Use Target Word, Emphasize**]
teacher emphasizes the word "severe"
Child(ren): no.
Ms. Thompson: oh boy /
Child(ren): xxx.
Ms. Thompson: let me tell you what it means.
Ms. Thompson: and then you tell me if you've, if you've heard that in the last couple days. [**Ask if Heard of Word**]

In this example, Ms. Thompson asked if students had heard the word *severe* and then gave a little context of where they might have heard the word before. In another lesson, Ms. Thompson introduced the term *friction* and, before explaining what it means, asked, "Who has heard of that word before?"

This *Metalinguistic & Metacognitive Awareness* vocabulary talk move aims to gauge students' awareness of target words as they are introduced. As reviewed in Chapter 2, the research on building students' metalinguistic and metacognitive awareness recommends instruction that teaches students to use contextual and morphemic analysis (e.g., Baumann et al., 2002, 2002, 2003, 2003; P. N. Bowers & Kirby, 2010; Freeman et al., 2019; Fukkink & de Glopper, 1998; Lubliner & Smetana, 2005; Nash & Snowling, 2006; Silverman et al., 2014; Wise, 2019), explain how word meanings are derived from context (Cain, 2007), detect semantic ambiguity (Zipke et al., 2009), and self-monitor and self-regulate (e.g., Boulware-Gooden et al., 2007; Lubliner & Smetana, 2005). The present study, however, shows that such metalinguistic and metacognitive awareness instruction was largely absent in these early-elementary science lessons.

In summary, the cohort of teachers used vocabulary talk moves from each of the four types of vocabulary talk. A majority of these vocabulary talk moves addressed building students' knowledge of word meanings, while fewer moves addressed interesting students in words and word learning, scaffolding students' word use, and building awareness of words and word learning.

Within-Teacher Comparisons of Vocabulary Talk

In addition to identifying the specific talk moves the cohort of teachers made, I made within-teacher comparisons in order to understand whether there were any patterns in the types of vocabulary talk moves individual teachers used. In other words, I was interested to see if any patterns emerged when looking from timepoint to timepoint within an individual teacher's data. Figure 2 shows the percentage of each type of vocabulary talk each teacher used at each of the three timepoints (i.e., 1: PrePD, 2: Week 5, 3: Week 9). With few exceptions, teachers used a greater percentage of *Knowledge & Understanding* vocabulary talk moves during each of their lessons than any other type of vocabulary talk. The exceptions are with two teachers who used little to no vocabulary talk in at least one of their lessons. Ms. Watson, first-grade teacher, made only one vocabulary talk move during her second lesson; therefore, as Figure 2 **Figure 2** shows, 100% of the vocabulary talk in this lesson addressed *Student Word Use*. She did not make any vocabulary talk moves during her third lesson. Similarly, Ms. Hill, second-grade teacher, did not make any vocabulary talk moves in her second lesson. Therefore, overall, when teachers used multiple vocabulary talk moves, a majority of these moves were aimed at building students' knowledge of word meanings. This is consistent with the previous finding that as a cohort, the teachers used a greater percentage of *Knowledge & Understanding* vocabulary talk moves across the three lessons than any other type of vocabulary talk (as shown in Table 4).

Further, this is reflective of the research literature on how children learn words, with most research focusing on building students' knowledge of word meanings.

Figure 2

Within-Teacher Comparisons of Vocabulary Talk Types Across Lessons

Figure 2 (cont'd)

Between-Teacher Comparisons of Vocabulary Talk

After making within-teacher comparisons, I made between-teacher comparisons in order to understand whether there were any trends for the cohort as a whole with vocabulary talk. In

other words, I was interested to see if any patterns emerged when looking from teacher to teacher across the entire dataset. Figure 3 shows the vocabulary talk moves per minute for each teacher at each of the three timepoints (i.e., 1: PrePD, 2: Week 5, 3: Week 9). As Figure 3 shows, all eight teachers engaged in more *Knowledge & Understanding* talk than any of the other types of vocabulary talk, and overall, none of the teachers engaged in much of the other types of talk. Although the teachers consistently engaged in the most *Knowledge & Understanding* talk, there is no pattern to the variation in this talk from lesson to lesson. That is, some teachers showed increases in *Knowledge & Understanding* talk from the PrePD lesson to the Week 5 lesson while others showed decreases—and some teachers showed increases from the Week 5 lesson to the Week 9 lesson while others showed decreases. Likewise, there is no consistent pattern to the variation in *Student Word Use* talk, *Metacognitive & Metalinguistic* talk, or *Affective Factors* talk from lesson to lesson. Therefore, there may be lesson-specific factors that impact how teachers engage in vocabulary talk. Research Question 3 in Chapter 5 takes a closer look at the science instruction of Ms. Thompson, kindergarten teacher, in order to explore features of science curriculum materials that may have contributed to the variance in vocabulary talk from lesson to lesson.

Figure 3

Between-Teacher Comparison of Vocabulary Talk Types Across Lessons

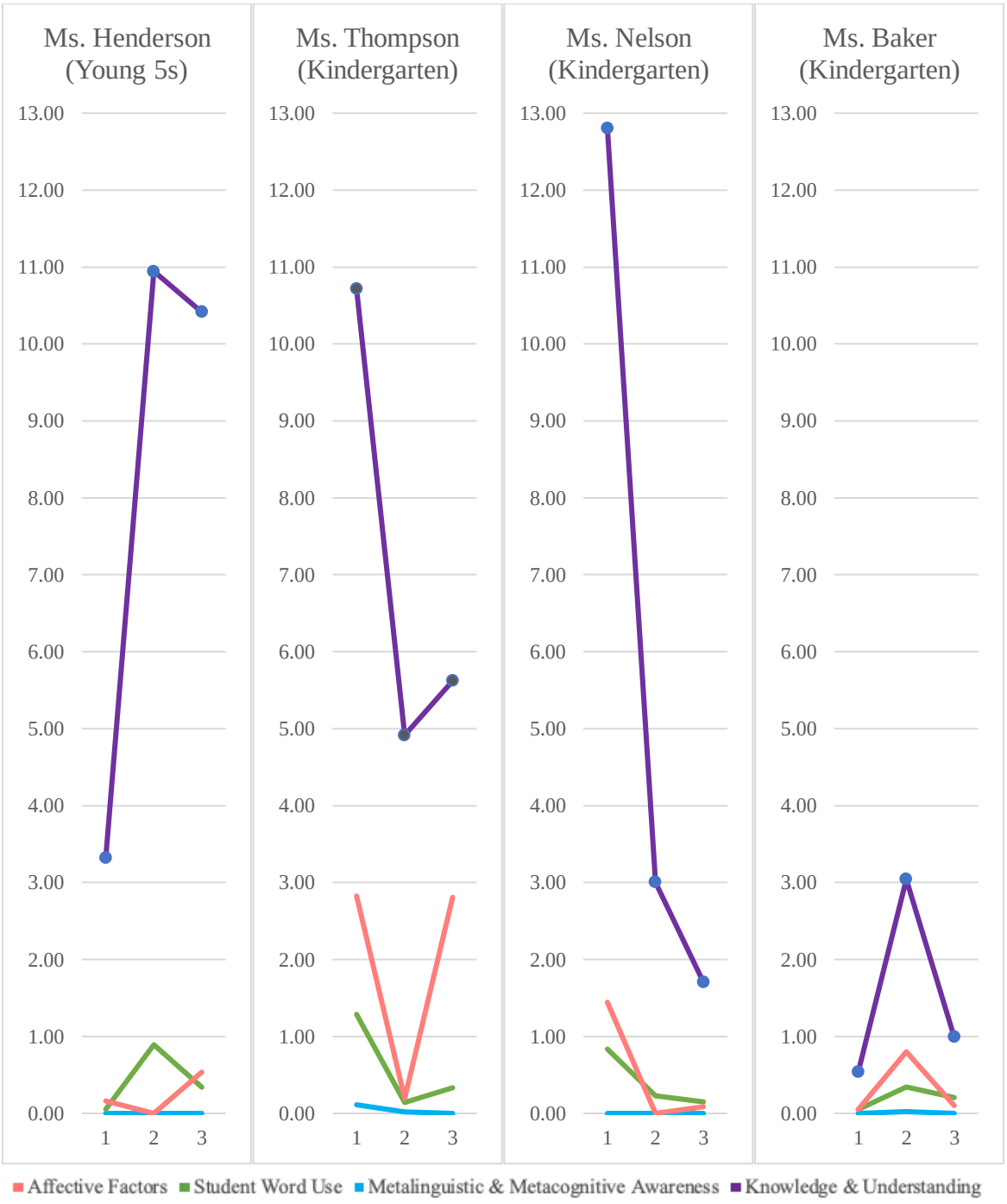


Figure 3 (cont'd)

Note: Rates show number of vocabulary talk moves per minute for each teacher.

In summary, the cohort of teachers engaged in considerably more *Knowledge & Understanding* vocabulary talk than *Student Word Use* talk, *Metacognitive & Metalinguistic* talk, or *Affective Factors* talk. This dominance of *Knowledge & Understanding* vocabulary talk is

apparent in both within- and between-teacher comparisons. This finding reflects the research base, as most research on how children learn words has focused on building students' knowledge of word meanings.

Research Question 2: Is Vocabulary Talk Related to the Language Aspects of Science Talk, and if so, How?

Given the potential intersection between vocabulary talk—talk that promotes oral language and vocabulary development—and the language aspects of science talk, which focus on teachers supporting students in (a) developing an understanding of science oral language within the context of science learning and (b) using science oral language to share their ideas and engage in science and engineering practices (Wright et al., 2017), I looked for a relationship between these two types of talk. Vocabulary talk and the language aspects of science talk were measured on different scales; therefore, I looked at overall trends between each teacher's vocabulary talk graph and science talk graph. (I will be shortening *language aspects of science talk* to merely *science talk* for the remainder of this chapter to support ease of reading; however, I am specifically referring to Components 1-2 of Domain 3 the SOLID Start Tool and not the full science talk construct.)

Figure 4

Ms. Henderson's Vocabulary Talk and Science Talk

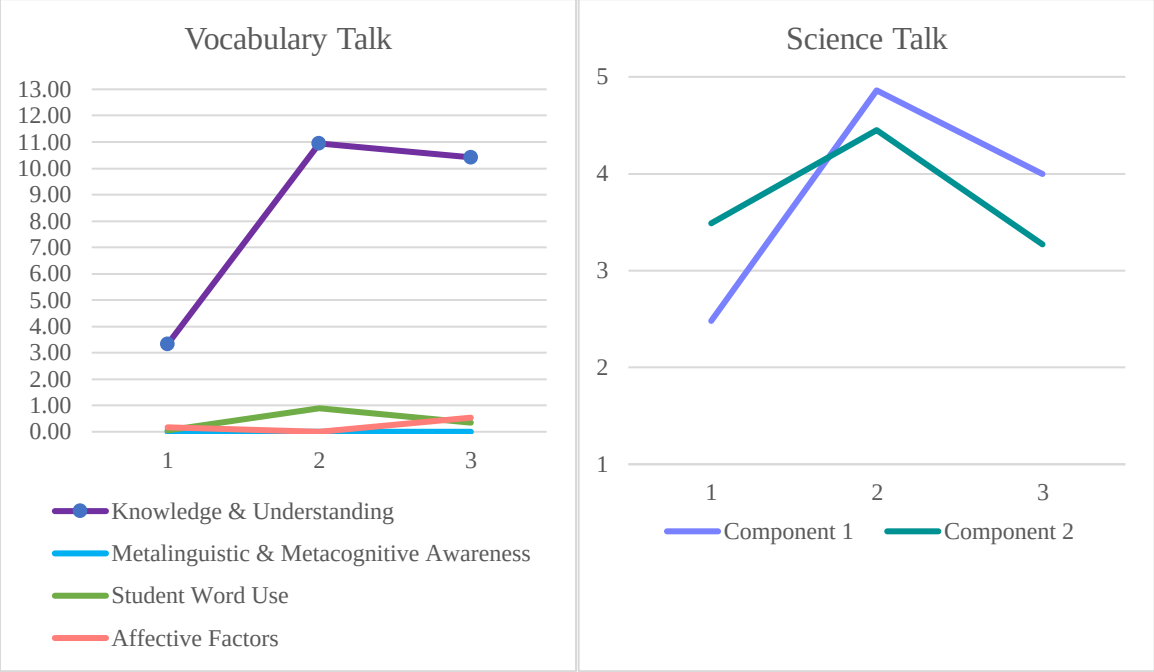


Figure 5

Ms. Baker's Vocabulary Talk and Science Talk

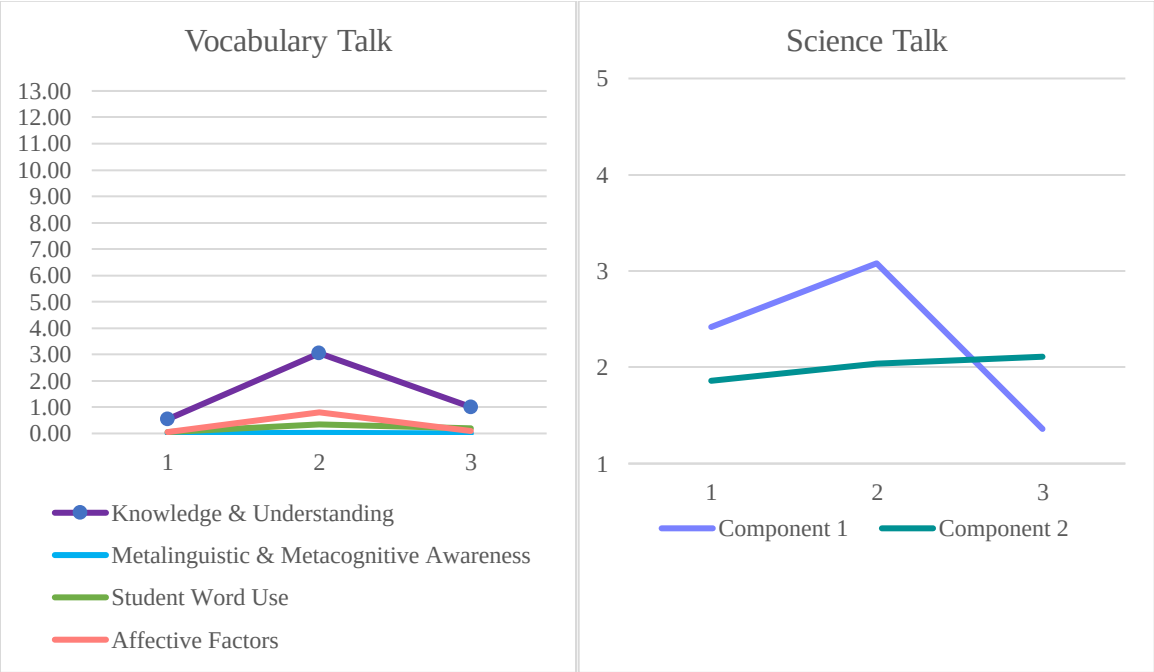


Figure 6

Ms. Watson's Vocabulary Talk and Science Talk

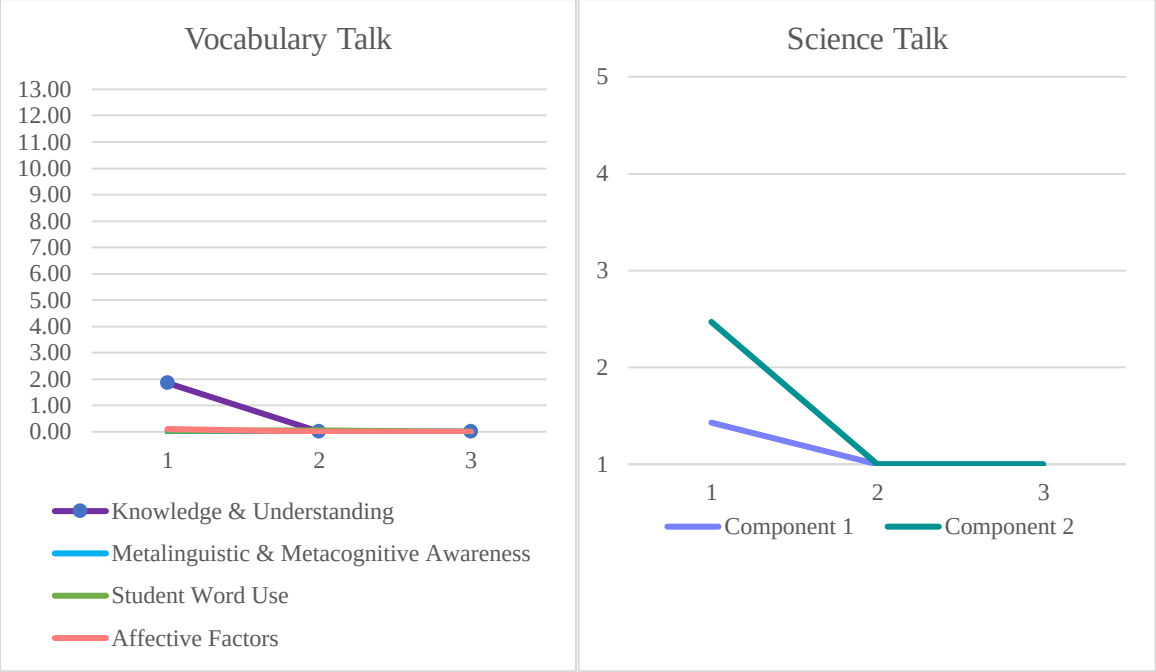


Figure 7

Ms. Griffin's Vocabulary Talk and Science Talk

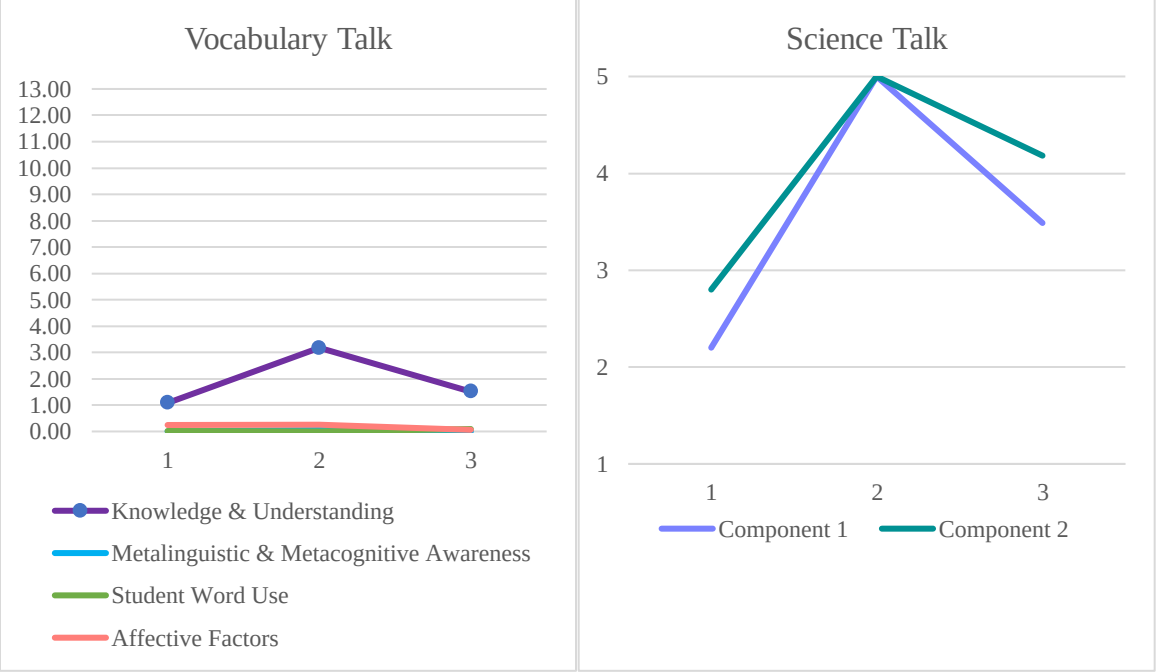
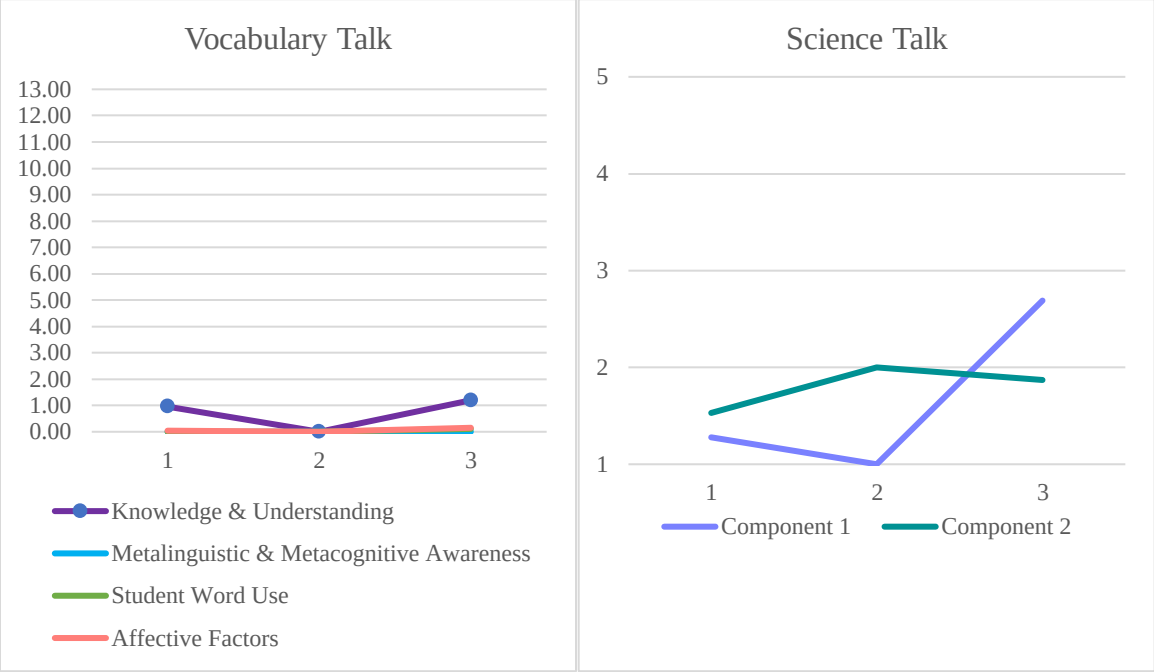


Figure 8

Ms. Hill's Vocabulary Talk and Science Talk



I found that the overall shape of the vocabulary talk graph was similar to the overall shape of the science talk graph for five of the teachers: Ms. Henderson (see Figure 4), Ms. Baker (see Figure 5), Ms. Watson (see Figure 6), Ms. Griffin (see Figure 7), and Ms. Hill (see Figure 8). In particular, the trend for *Knowledge & Understanding* within vocabulary talk and the trend for *Component 1* within science talk reflect one another in these graphs. This relationship makes sense, as the *Knowledge & Understanding* vocabulary talk moves focus on building students' knowledge of word meanings and *Component 1* of science talk focuses on how teachers support students in developing an understanding of science oral language within the context of science learning. The overall focus, therefore, is on developing understanding of word meanings. The relationship between the trend for *Student Word Use* within vocabulary talk and the trend for *Component 2* within science talk is less clear. Theoretically, these are also related, as *Student Word Use* vocabulary talk moves focus on teacher talk that scaffolds students' word use and

Component 2 of science talk focuses on teachers' scaffolding of students' use of discipline-specific oral language within the context of discussing ideas and engaging in science and engineering practices. The overall focus here is on scaffolding students' use of words. However, because there were very few code applications for *Student Word Use* vocabulary talk moves, it is difficult to see if there is a relationship between this type of vocabulary talk and *Component 2* of science talk. Therefore, *Knowledge & Understanding* vocabulary talk appears to be related to the language aspects of science talk focused on building knowledge of science oral language (i.e., *Component 1*), but the relationship between *Student Word Use* vocabulary talk and the language aspects of science talk focused on scaffolding students' word use (i.e., *Component 2*) requires further study.

Figure 9

Ms. Nelson's Vocabulary Talk and Science Talk

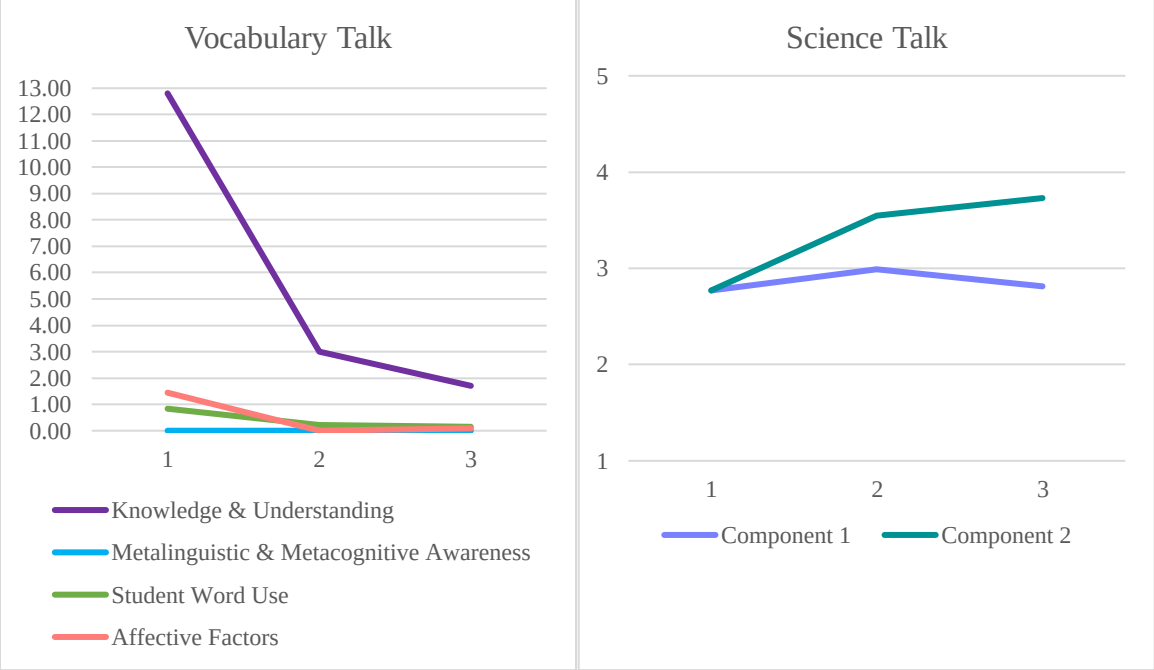
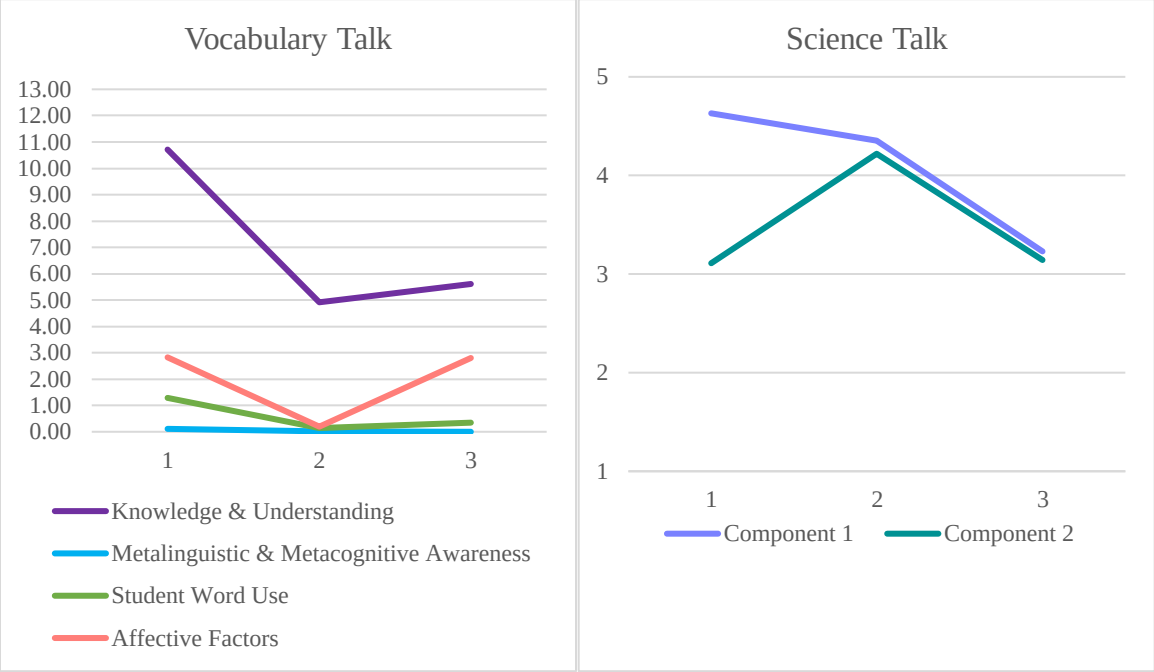


Figure 10

Ms. Thompson's Vocabulary Talk and Science Talk



The overall shape of the vocabulary talk graph was not similar to the overall shape of the science talk graph for Ms. Nelson (see Figure 9) and Ms. Thompson (see Figure 10), and this disconnect highlights the difference between noting that vocabulary talk is happening (as depicted in the vocabulary talk graphs) and noting the quality of the vocabulary instruction (as depicted in the science talk graphs). For example, Ms. Nelson's PrePD lesson (timepoint 1 on graph) was on the 100th day of school, and she encouraged her kindergarten students to come up with 100 science words they had learned so far in the *SOLID Start* Weather Forecasting unit as a way of getting back into the unit after missing more than a week of school due to severe winter weather. During the lesson, she elicited students' ideas about what weather words they had learned and what they meant. She also elicited examples of these words (e.g., types of precipitation) from students and offered confirmation or clarification. Ms. Nelson recorded all of these words on the board, grouping related words together (e.g., *hail, snow, sleet, rain* listed

under *precipitation*). She provided multiple exposures to these words throughout the lesson and drew attention to them with emphasis. She also helped students make personal connections to many of these target words and prompted students to use them. Therefore, Ms. Nelson engaged in a great deal of vocabulary talk in general and a great deal of *Knowledge & Understanding* talk in particular, as evidenced by her rate of 12.81 *Knowledge & Understanding* moves per minute. However, much of this vocabulary talk did not happen within the context of science learning, which is reflected in the *Component 1* composite score of 2.77. Similarly, although students were listing many science words, they were not using these words to discuss their ideas or engage in science and engineering practices, which is reflected in the *Component 2* composite score of 2.77. Thus, the quantity of vocabulary talk within the lesson did not align with the quality of the vocabulary instruction.

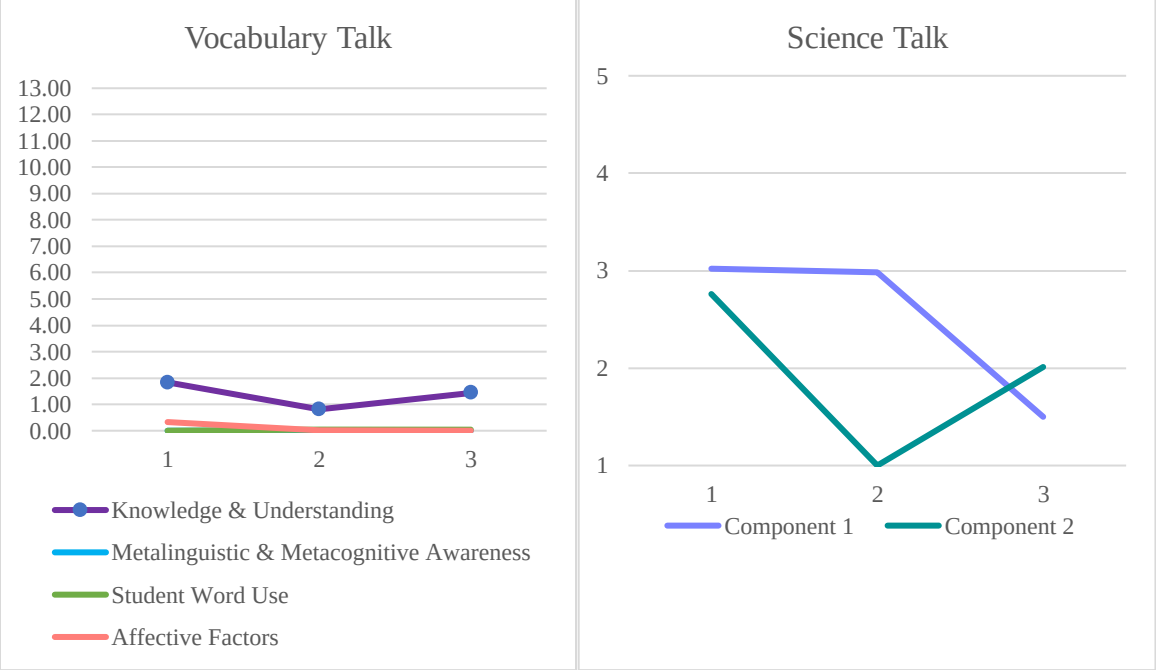
This disconnect is also apparent in Ms. Thompson's second lesson (see Figure 9). In this lesson, Ms. Thompson engaged in *Knowledge & Understanding* talk less frequently than in her other two lessons; however, *Component 1* scored nearly as high as with her first lesson. Further analysis shows that when she did introduce and review the meaning of science oral language, she did so in a child-friendly way within the context of science learning. In other words, the quantity of her vocabulary talk was relatively low, but the quality of this instruction was high. Likewise, Ms. Thompson engaged in little *Student Word Use* talk in her second lesson, but the lesson scored relatively high for *Component 2* compared to her other two lessons. Further analysis shows that when her kindergarten students used science oral language, it was to share their ideas and engage in science practices (i.e., within an investigation). Therefore, the quantity of talk scaffolding students' word use was low, but the quality of vocabulary instruction engaging

students in using science oral language was relatively high. Once again, the quality of vocabulary instruction was not captured by the counts of vocabulary talk use.

This finding points to the need to consider both the ways in which teachers use vocabulary talk moves to promote oral language and vocabulary development *and* the overall quality of this vocabulary talk. This is important because, for these vocabulary talk moves to be effective in promoting students' oral language and vocabulary development, the quality of the vocabulary talk likely matters. Therefore, studies examining the relationship between teachers' vocabulary talk and students' oral language and vocabulary development need to take into consideration both what vocabulary talk moves were made and what the quality of that vocabulary talk was.

Figure 11

Ms. Howard's Vocabulary Talk and Science Talk



Finally, the overall shape of the vocabulary talk graph was not very similar to the overall shape of the science talk graph for Ms. Howard (see Figure 11), but in this case, this does not

reflect a disconnect between quantity and quality of talk. Rather, Ms. Howard engaged in very little vocabulary talk (low quantity) at all three timepoints, and her science talk scores were under 3.0 for all three time points (low quality). In other words, the quantity of vocabulary talk and quality of vocabulary instruction were consistently low across all three timepoints. Therefore, while comparing the overall shapes of the vocabulary talk and science talk graphs provides some insight into how vocabulary talk relates to the language aspects of science talk, future research examining this relationship may be enhanced with a more precise approach.

Summary of Findings

The cohort of teachers used vocabulary talk moves across the four types of vocabulary talk, with a majority of vocabulary talk moves (i.e., 21 different moves) and vocabulary talk code applications (i.e., 86.72%) aimed to build students' knowledge and understanding of word meanings and considerably fewer moves (i.e., 13 moves total) and code applications (i.e., 13.28% combined) dedicated to interesting students in words and word learning, scaffolding students' word use, and building awareness of words and word learning. This dominance of *Knowledge & Understanding* vocabulary talk is apparent in both within- and between-teacher comparisons.

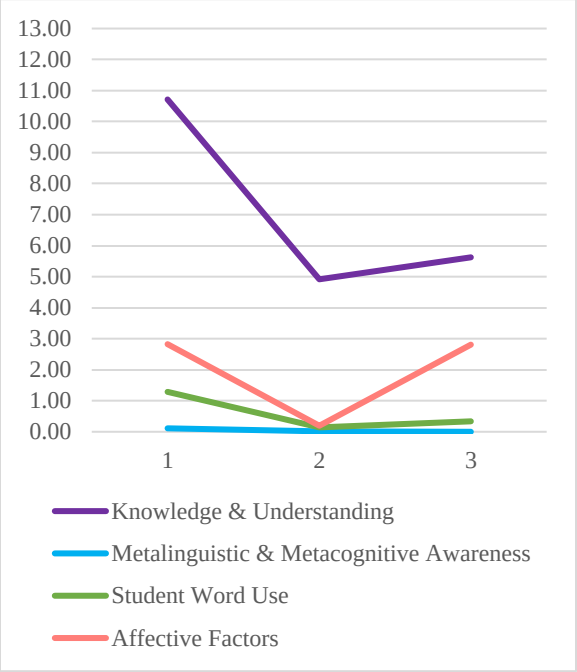
While there does appear to be a relationship between *Knowledge & Understanding* vocabulary talk and the language aspects of science talk focused on building knowledge of science oral language (i.e., *Component 1*), further research is needed to examine whether a relationship exists between *Student Word Use* vocabulary talk and the language aspects of science talk focused on scaffolding students' word use (i.e., *Component 2*). Further, this analysis points to the need to consider the context in which vocabulary talk moves are made and the overall quality of this vocabulary talk in addition to examining which moves the teachers make.

CHAPTER 5—STUDY 2 FINDINGS: RESEARCH QUESTION 3

The primary goal of this study was to describe the relationship between curricular features of science materials and a kindergarten teacher's enhanced vocabulary talk. I report findings based on 128.03 minutes of observational data across three total lessons, ranging from 35:45 to 56:21, in Ms. Thompson's kindergarten classrooms. Ms. Thompson's science instruction was selected for this analysis because she taught from a different set of curriculum materials for each of her three lessons, providing an opportunity to investigate how the different curricular features within these sets of materials may have contributed to the considerable variance in Ms. Thompson's talk (i.e., within-subject differences) across the three science lessons (see Figure 12). In this study, I investigated the following research question: What features of science curriculum materials are related to a kindergarten teacher's enhanced vocabulary talk? In this chapter, I first describe the three lessons Ms. Thompson taught, as presented by the three sets of curriculum materials. Then I present three curricular features that may be associated with Ms. Thompson's vocabulary talk, along with transcripts depicting how vocabulary talk varied relative to these features.

Figure 12

Ms. Thompson's Vocabulary Talk



Note: Rates show number of vocabulary talk moves per minute.

The Lessons

In this section, I describe the three lessons Ms. Thompson drew from when teaching her three video recorded lessons. Note that these descriptions are of the written lessons, as presented by the curriculum materials, rather than the enacted lessons.

SOLID Start: How Can We Prepare for Severe Weather Conditions?

For the first video recorded lesson (i.e., PrePD), Ms. Thompson drew from the *SOLID Start* (Gotwals & Wright, 2017; Wright & Gotwals, 2017) kindergarten Weather Forecasting unit, teaching Lesson 7: *How Can We Prepare for Severe Weather Conditions?* This lesson is from a 10-lesson unit exploring the driving question *How Does Our Weather in [Your Location] Change Over Time?* The lesson overview estimates this to be a 50-minute lesson and shows five lesson activities with the following descriptions:

- Ask: Review types of precipitation and introduce Lesson Question
- Explore: Students consider ways to prepare for different types of precipitation.
- Read: *What Is Severe Weather?* by Jennifer Boothroyd and *What Is Precipitation* by Robin Johnson
- Write: The teacher and students create a class list of how to prepare for different types of severe weather.
- Synthesize: Students discuss severe weather and connect it to the Driving Question.

The frontmatter to the lesson also includes the following components:

- Lesson Question: *How Can We Prepare for Severe Weather Conditions*?
- I-can statements: *I can describe types of weather conditions in my state. I can explain why it is important to prepare for severe weather*.
- Relevant NGSS performance expectation components (NGSS Lead States, 2013):
    - Disciplinary Core Idea: *ESS3.B: Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events.*
    - Crosscutting Concept: *Patterns: Students should identify patterns in their observations of the natural world. These patterns can be used as evidence.*
    - Science and Engineering Practices: *Obtaining, Evaluating, and Communicating Information: Students should read texts or use other media to obtain information about patterns in the natural world or to obtain evidence. In texts, student should be able to interpret diagrams. Evidence should be obtained from multiple sources to answer scientific questions. Students should communicate their ideas orally, in writing, or in drawings.*

- New science content vocabulary with child-friendly definitions: *severe, flood, snowstorm, tornado, hurricane*
- List of vocabulary to review/reinforce from previous lessons: weather conditions, *rain, snow, wind, season, fall, winter, spring, summer, cool, cold, warm, hot, prepare, measure, meteorologist, precipitation, thunderstorm*
- List of materials for lesson

The lesson plan itself details each of the five lesson activities, with vocabulary terms introduced at specific points in the lesson using the given child-friendly definitions and with discussion questions provided throughout. Additionally, teaching tips appear alongside the lesson plan, with recommendations for teachers. For example, the following tip accompanies the Ask activity: *Encourage students to use the vocabulary words they have learned from previous lessons when discussing precipitation*. At the end of the lesson plan is a sample summary table with examples of what the lesson's entries could include. For example, for the column *What Did We Learn? (Claims) (statements)*, the sample text reads: *Severe weather is dangerous, and it is important to stay inside and usually it is also important to stay away from windows*.

***Teachers Pay Teachers*: A Push Is a Force!**

Ms. Thompson drew from a teacher-created packet of kindergarten lesson materials from *Teachers Pay Teachers* for her second video recorded lesson (i.e., Week 5). The packet contains two force and motion activities. Ms. Thompson's lesson used the first activity: *A Push Is a Force!* The following components were included in the packet for this activity:

- Performance expectation: K-PS2-1 [*Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object* (NGSS Lead States, 2013)]

- List of materials for the activity
- Instructions for the activity
- Two templates to print, laminate, and cut out for the activity
- Three photographs with captions showing how to set up the activity and how to have students record their responses
- Two students sheets and an answer key

During this activity, the students predict how far their toy car will go after being pushed with "medium" and "hard" force. Then they take turns pushing their cards and recording the results. The activity description does not mention how the worksheet entitled *Why does the car stop moving?* fits into the activity, but the answer key indicates that the word students are to write in the blank is *friction*, implying that friction is discussed at some point in the activity.

***Mystery Science*: Where Do Animals Live?**

For the third video recorded lesson (i.e., Week 9), Ms. Thompson drew from the *Mystery Science* (Schacht & Peltz, 2020) kindergarten Plant and Animal Secrets unit, teaching Lesson 2: *Where Do Animals Live?* This web-based lesson is from a 6-lesson unit focused on helping kindergarten students understand that animals and plants need things to survive and that they do the things they do in order to meet their needs. The following components comprise the online lesson materials:

- Overview identifying grade level (K), topic (*Plant & Animal Needs*), and focus (*Animal Needs: Shelter*)
- 25-minute digital text (i.e., slides with video-recorded pages) *Who Lives There?*
- A description of the lesson labeled "Activity Prep" and "Prep Instructions" with a suggestion (and link) for the optional activity

- "Extensions" with links for Google Classroom (to assign the video), a PDF to download for assessment (with space for students to draw an animal in its home and write about it with the sentence frames "My animal is a…" and "It makes its home in…"), the optional activity (one-minute video and three discussion questions), the transcript of the lesson introduction video (part of the digital text), and a link to embed the lesson on a class website.

This lesson explores the question *Where do animals live?* and is labeled as a "Read-Along" lesson. For this lesson, the teacher advances slides through the video-recorded reading of a digital text. Afterward, there is an optional activity to show a one-minute video and facilitate a discussion with the three given prompts. This optional video and discussion is labeled as a 20-minute "hands-on activity." Additionally, the K-5 planning guide available on the website identifies the following NGSS alignment for this lesson:

- Performance expectation: *K-ESS3-1* [*Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live* (NGSS Lead States, 2013)]
- Topic: *Animal Homes*
- Disciplinary Core Ideas: *ESS3.A Living things need food, water, shelter, and many other resources to survive! All living things live in places that provide the needs they have to survive. Not all living things live in a house, like humans do. Animals live in many different types of homes close to their resources.*
- Science and Engineering Practices: *Students obtain information through media about how different animal homes are built. They communicate this information in order to identify patterns in the natural world.*

- Crosscutting Concepts: *Students identify the pattern that all living things live where their needs are met. They recognize that plants, animals, and their surroundings make up a system as parts that work together.*

In summary, the *SOLID Start* lesson identifies components of the NGSS performance expectations it addresses, includes five activities, targets vocabulary words for instruction through introduction or review/reinforcement, and provides recommendations to teachers—including some for supporting oral language and vocabulary development. The *Teachers Pay Teachers* activity identifies the NGSS performance expectation it addresses and provides templates and instructions for the activity. Finally, the *Mystery Science* lesson provides a digital text with video recorded pages and an optional activity with a video clip and discussion prompt (and the planning guide shows alignment with NGSS). In the sections that follow, I share my findings for Research Question 3: What features of science curriculum materials are related to a kindergarten teacher's enhanced vocabulary talk?

Targeted Vocabulary

The identification of specific vocabulary words targeted for instruction within a lesson by science curriculum materials was related to Ms. Thompson's enhanced vocabulary talk. This was apparent in the *SOLID Start* Weather Forecasting lesson, which identifies five new vocabulary words (i.e., *severe, flood, snowstorm, tornado,* and *hurricane*) to introduce at specific points within the lesson, provides child-friendly explanations for each, and offers discussion questions to engage students in active processing (Stahl & Fairbanks, 1986) of the target words. For example, the lesson directs teachers to provide instruction on the target word *severe* within the context of introducing the lesson question: *How can we prepare for severe weather conditions?*

The lesson provides “dangerous or extreme” as the child-friendly explanation and offers the following sample questions for eliciting students’ initial ideas:

- *What are some examples of severe weather you are familiar with?*
- *What are some things you have learned about preparing for severe weather?*
- *What are some questions you have about severe weather?*

The following transcript shows Ms. Thompson’s vocabulary talk as she introduced the targeted vocabulary term *severe*:

> Ms. Thompson: this word says severe. [**Introduce Word, Use Target Word, Emphasize, Visually Display Word**]
> *teacher has written “severe” on a small whiteboard; teacher emphasizes the word “severe”*
> Child(ren): severe?
> Ms. Thompson: thumbs up if you've ever heard that word before? [**Ask if Heard of Word**]
> *many students give thumbs up*
> Ms. Thompson: uh, in the past three, four days, we've had some severe weather conditions. [**Use Target Word, Emphasize, Provide Example/Nonexample, Help Students Make Personal Connection**]
> *teacher emphasizes the word “severe”*
> Ms. Thompson: do you agree?
> Ms. Thompson: have you heard anybody say that on the news? [**Ask if Heard of Word**]
> Ms. Thompson: or your parents use that word? [**Ask if Heard of Word**]
> Ms. Thompson: severe? [**Use Target Word, Emphasize**]
> *teacher emphasizes the word “severe”*
> Child(ren): no.
> Ms. Thompson: oh boy /
> Child(ren): xxx.
> Ms. Thompson: let me tell you what it means.
> Ms. Thompson: and then you tell me if you've, if you've heard that in the last couple days. [**Ask if Heard of Word**]
> Ms. Thompson: it means dangerous. [**Explain/Define, Emphasize**]
> *teacher emphasizes the word “dangerous”*
> Ms. Thompson: has the weather in the last few days been dangerous? [**Help Students Make Personal Connection**]
> Child(ren): yeah, the only dangerous weather is tornadoes.
> Ms. Thompson: that's not the only dangerous //
> Ms. Thompson: why couldn't you go outside? [**Help Students Make Personal Connection**]

Ms. Thompson: why didn't we go to school yesterday? [**Help Students Make Personal Connection**]
Child(ren): because severe xxx frostbite.
Ms. Thompson: it was severe. [**Use Target Word, Emphasize, Help Students Make Personal Connection, Use with Hint**]
teacher emphasizes the word "severe"
Ms. Thompson: it was dangerous. [**Emphasize, Help Students Make Personal Connection, Use with Hint**]
teacher emphasizes the word "dangerous"
Ms. Thompson: <it was //>
Child(ren): <you could get a frostbite in one minute>.
Ms. Thompson: from what?
Child(ren): five, five minutes.
Ms. Thompson: I'm thinking of the therm /
Child(ren): five.
students arguing in background about number of minutes before frostbite sets in
Ms. Thompson: we're not going to argue about this.
Ms. Thompson: what was severe about the weather yesterday? [**Use Target Word, Help Students Make Personal Connection**]
Ms. Thompson: why can you get frostbite? [**Help Students Make Personal Connection**]
teacher emphasizes the word "why"
Ms. Thompson: because it was what, Myles? [**Help Students Make Personal Connection**]
Child(ren): way too cold.
Ms. Thompson: it was too cold. [**Help Students Make Personal Connection**]
Ms. Thompson: the temperature was severe. [**Use Target Word, Emphasize, Provide Example/Nonexample, Help Students Make Personal Connection**]
teacher emphasizes the words "temperature" and "severe"
Ms. Thompson: say that sentence. [**Ask to Repeat**]
Ms. Thompson: <the temperature was severe>. [**Use Target Word, Emphasize, Use with Hint, Help Students Make Personal Connection**]
teacher emphasizes the words "temperature" and "severe"
Child(ren): <the temperature was severe>.
Ms. Thompson: it was dangerous. [**Emphasize, Visually Display Word, Use with Hint, Help Students Make Personal Connection**]
teacher emphasizes the word "dangerous" and points to it on whiteboard
Ms. Thompson: do you agree?
Child(ren): yeah.
Ms. Thompson: it was //
Ms. Thompson: here's another good word. [**Appreciate Word/Word Choice**]
teacher writes word on whiteboard
Ms. Thompson: it was extreme. [**Introduce Word, Use Target Word, Emphasize, Visually Display Word, Help Students Make Personal Connection**]
teacher emphasizes the word "extreme"
Ms. Thompson: try that word. [**Ask to Repeat**]
Ms. Thompson: <extreme>. [**Use Target Word, Emphasize**]

teacher emphasizes the word "extreme"

Child(ren): <extreme>.

Ms. Thompson: extreme means so so so so so. [**Use Target Word, Explain/Define**]

Ms. Thompson: was it so so so so so cold? [**Emphasize, Help Students Make Personal Connection**]

teacher emphasizes "so so so so so"

Child(ren): yeah.

Ms. Thompson: instead of saying so so so so so, we could say it was extreme. [**Use Target Word, Emphasize, Use with Hint, Offer Alternative, Help Students Make Personal Connection**]

teacher emphasizes "so so so so so" and "extreme"

Ms. Thompson: it was severe. [**Use Target Word, Use with Hint, Help Students Make Personal Connection**]

Ms. Thompson: it was dangerous. [**Use with Hint, Help Students Make Personal Connection**]

Ms. Thompson: it was extreme. [**Use Target Word, Emphasize, Visually Display Word, Help Students Make Personal Connection**]

teacher emphasizes "extreme" and points to the word on the whiteboard.

Ms. Thompson: do you agree?

Child(ren): xxx.

Ms. Thompson: it hurt your face if you went outside or your throat if you were breathing the air. [**Provide Example/Nonexample, Help Students Make Personal Connection**]

This example shows the relationship between the *SOLID Start* lesson's (a) identification of the target word *severe*, (b) provision of a child-friendly explanation, and (c) offering of sample questions for engaging students further with the meaning of the word and Ms. Thompson's enhanced vocabulary talk. In Ms. Thompson's enactment of the lesson, she used part of the definition provided (i.e., *dangerous*) to explain the meaning of *severe* and then introduced *extreme* (the other part of the child-friendly definition provided by the *SOLID Start* lesson) as its own target word. She provided students with multiple exposures to these words in a variety of contexts, with 17 exposures for *severe* and 12 for *extreme* (not including instances in which these terms were read from text). Ms. Thompson connected these terms to recent severe weather the children had all experienced, as school had been canceled for more than a week due to extreme cold and a prolonged period of snowfall. Ms. Thompson encouraged students to say these words

aloud and visually displayed these words as she talked about them. Following the transcript shown here, Ms. Thompson used a variation of one of the sample questions provided to engage students further in a discussion regarding preparing for severe weather. (See next paragraph for transcript of this discussion). Ms. Thompson's thorough introduction of the term *severe* with a variety of vocabulary talk moves is seemingly related to its identification as a target word. Ms. Thompson consistently engaged in this kind of dense vocabulary talk throughout the lesson in places in which the *SOLID Start* lesson had identified target words to introduce or review, indicating a relationship between targeted vocabulary words and enhanced vocabulary talk.

The *SOLID Start* lesson also identifies 18 previously-introduced vocabulary words (e.g., *weather conditions, meteorologist, precipitation*) to be reviewed and reinforced within the current lesson, providing multiple exposures to these words and highlighting connections between them and newly-introduced target words. (See Table 5 for complete list of words identified in the *SOLID Start* lesson for review and reinforcement.) Accompanying this list of words is the following teaching tip: *These words are from past lessons to review and reinforce throughout this lesson. Repetition and multiple exposures to words support vocabulary development. For science content words, draw students' attention to the Word Wall*. In the following example, Ms. Thompson reviews/reinforces the target word *prepare* (from Lesson 2 in the *SOLID Start* Weather Forecasting unit) while engaging students in a discussion related to the new target word *severe*:

Ms. Thompson: here's another word.
Ms. Thompson: this makes me think of what you did if you went outside yesterday. [**Help Students Make Personal Connection**]
Ms. Thompson: you really had to // [**Help Students Make Personal Connection**]
Ms. Thompson: look at this word.
teacher writes the word on the whiteboard
Ms. Thompson: you had to prepare. [**Review Word, Use Target Word, Emphasize, Visually Display Word, Help Students Make Personal Connection**]

teacher emphasizes the word "prepare"

Ms. Thompson: what does prepare mean? [**Use Target Word, Emphasize, Use Target Word, Elicit Student Ideas: Review Word**]

teacher emphasizes the word "prepare"

Child(ren): get all your snow stuff, I get ready /

Ms. Thompson: get ready. [**Emphasize, Explain/Define**]

teacher emphasizes "get ready"

Ms. Thompson: you had to get ready. [**Emphasize, Explain/Define, Help Students Make Personal Connection**]

teacher emphasizes "get ready"

Ms. Thompson: so prepare means get ready. [**Use Target Word, Explain/Define**]

Ms. Thompson: what do you have to do to get ready for that extreme weather we had yesterday? [**Use Target Word, Emphasize, Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]

teacher emphasizes "get ready" and "extreme"

Ms. Thompson: what would you have to do? [**Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]

Child(ren): xxx.

Ms. Thompson: put your what? [**Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]

Child(ren): snow gear on.

Ms. Thompson: put your snow gear on. [**Provide Example/Nonexample, Help Students Make Personal Connection**]

Ms. Thompson: what else did you have to do to prepare? [**Use Target Word, Emphasize, Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]

teacher emphasized the word "prepare"

Child(ren): xxx, scarf, xxx.

Ms. Thompson: scarves?

Ms. Thompson: you know what I did to prepare? [**Use Target Word, Emphasize**]

teacher emphasized the word "prepare"

Ms. Thompson: before the weather, before the severe weather came? [**Use Target Word, Emphasize**]

teacher emphasized the word "severe"

Ms. Thompson: I went to the grocery store. [**Provide Example/Nonexample**]

Ms. Thompson: and I made sure I had enough food at home. [**Provide Example/Nonexample**]

Ms. Thompson: did anyone else's family go shopping so you made sure you had enough food at home? [**Help Students Make Personal Connection**]

Child(ren): I don't know.

Ms. Thompson: you know what else I did to prepare? [**Use Target Word, Emphasize**]

teacher emphasized the word "prepare"

Ms. Thompson: I filled my gas tank up with gas. [**Provide Example/Nonexample**]

Ms. Thompson: because I did not want to have to go to the gas station when it was severe weather outside. [**Use Target Word, Emphasize, Visually Display Word, Example/Nonexample**]

teacher holds up whiteboard and emphasizes the word "severe"

Ms. Thompson: it would have been dangerous for me to stand outside. [**Emphasize**]

teacher points to the word "dangerous" on the whiteboard and emphasizes it

Ms. Thompson: I could have hurt my face or my skin.

Ms. Thompson: so I prepared by getting groceries, by getting gas in my gas tank. [**Use Target Word, Provide Example/Nonexample**]

Ms. Thompson: and if I did go outside, what do you think I wore? [**Elicit Student Ideas: Example/Nonexample**]

Ms. Thompson: when I went to lunch with Kyle yesterday, what do you think I wore? [**Elicit Student Ideas: Example/Nonexample**]

Child(ren): snow clothes, scarf.

Ms. Thompson: a scarf?

Ms. Thompson: yes, I did. [**Provide Example/Nonexample**]

Child(ren): xxx.

Ms. Thompson: gloves. [**Provide Example/Nonexample**]

Ms. Thompson: what else did I wear? [**Elicit Student Ideas: Example/Nonexample**]

Child(ren): coat.

Ms. Thompson: a coat. [**Provide Example/Nonexample**]

Child(ren): snow pants.

Ms. Thompson: snow pants. [**Provide Example/Nonexample**]

Ms. Thompson: what else? [**Elicit Student Ideas: Example/Nonexample**]

Child(ren): xxx.

Ms. Thompson: boots on my feet. [**Provide Example/Nonexample**]

Ms. Thompson: and a hat on my head. [**Provide Example/Nonexample**]

Child(ren): xxx.

Ms. Thompson: I had to prepare because the weather / [**Use Target Word, Emphasize, Visually Display Word**]

teacher emphasized "prepare" and points to it on whiteboard

Child(ren): xxx pants on.

Ms. Thompson: I had to prepare because the weather was... [**Use Target Word, Prompt Word, Visually Display Word**]

teacher prompts students and is still holding up whiteboard with word "severe"

Child(ren): <severe>.

Ms. Thompson: <severe>. [**Use Target Word, Emphasize**]

teacher emphasizes "severe"

Ms. Thompson: when the weather is going to be severe, you have to prepare. [**Use Target Word, Emphasize, Help Students Make Personal Connection**]

teacher emphasizes "prepare"

Ms. Thompson: you have to prepare. [**Use Target Word, Help Students Make Personal Connection**]

Child(ren): you have to put a scarf on.

Ms. Thompson: yes, all of those things. [**Provide Example/Nonexample**]

In this transcript, Ms. Thompson elicited students' ideas to review the meaning of *prepare* and to generate examples of preparing within the context of severe winter weather. Ms. Thompson also

provided examples of preparing and helped students make personal connections to their recent shared experience with severe winter weather. By using the term *prepare* repeatedly throughout the discussion, she provided multiple exposures, as suggested in the lesson's teaching tip. She also drew attention to the word by repeatedly emphasizing it. Once again, Ms. Thompson's in-depth review and reinforcement of the word *prepare* with a variety of vocabulary talk moves seems to be related to its designation as a target word to be reviewed and reinforced by the *SOLID Start* curriculum materials.

In addition to the terms targeted for instruction by the *SOLID Start* lesson, Ms. Thompson, on her own, also targeted seven words for instruction or review/reinforcement by bringing students' awareness to them and their meanings. Of these words, four were targeted for instruction in previous *SOLID Start* Weather Forecasting lessons but did not appear in the list of words to review/reinforce at the beginning of this particular lesson (i.e., *breezy, calm, stratus, cumulonimbus*). Although these words were not targeted for review/reinforcement within this particular lesson, Ms. Thompson's decision to do so within the current lesson may be related to their identification as target words in previous lessons. Two of the words targeted by Ms. Thompson were not words targeted for instruction by the *SOLID Start* curriculum but were discussed in previous lessons (i.e., *wind flag, storm clouds*). The final word targeted for instruction by Ms. Thompson was *severe*, which was provided as part of the child-friendly explanation of *severe* within the current lesson. Therefore, the words Ms. Thompson targeted for instruction on her own were words previously targeted for instruction or were related to words targeted for instruction by the *SOLID Start* curriculum materials, once again suggesting that having targeted vocabulary words enhanced Ms. Thompson's vocabulary talk. In the following transcript, Ms. Thompson briefly reviews *breezy* as part of an activity in which students match

the clothing items they would need to wear in order to be prepared to play outside to the given type of weather conditions and season:

> Ms. Thompson: what're the weather conditions usually in the fall? [**Use Target Word**]
> Child(ren): light, light wind.
> Ms. Thompson: light //
> Ms. Thompson: love that! [**Praise**]
> Ms. Thompson: maybe we could say the word (2) *breezy*? [**Prompt, Suggest Word/Phrase**]
> *teacher pauses for two seconds and waves hand as if it is blowing slightly in a breeze—seems to be trying to prompt students*
> Ms. Thompson: maybe breezy. [**Use Target Word**]
> Ms. Thompson: so what would you wear on your body if it's, if it's going to be breezy? [**Use Target Word, Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]

In this example, Ms. Thompson scaffolded students' word use by prompting students to use the previously-introduced target word *breezy.* When students did not take up this prompt, she suggested *breezy* as a more precise way to say "light wind." She then elicited students' ideas for examples of what they would need to wear in order to be prepared to play outside if it were a breezy fall day. If *breezy* had not been introduced as a target word in a previous lesson within the unit, it is possible that Ms. Thompson would have accepted "light wind" and continued the discussion. The fact that *breezy* had been targeted for instruction previously may be related to Ms. Thompson's vocabulary talk within this activity.

Table 5

Words Targeted for Instruction

Type of Target Word	*SOLID Start* Weather Forecasting Lesson	*Teachers Pay Teachers* Force and Motion Lesson	*Mystery Science* Plant and Animal Secrets Lesson
Words Targeted by Curriculum to Introduce in Lesson	severe (17) flood (3) snowstorm (2) tornado (10) hurricane (0)	friction (16)	(no words identified)

Table 5 (cont'd)

Words Targeted by Curriculum to Review/Reinforce in Lesson	weather conditions (2) rain (19) snow (8) wind (58) fall (5) winter (3) spring (1) summer (1) cool (0) cold (2) warm (7) hot (0) prepare (18) measure (0) meteorologist (0) precipitation (4) thunderstorm (0)	(no words identified)	(no words identified)
Words Targeted by Teacher for Introduction or Review/ Reinforcement	(wind) flag (14) breezy (7) calm (0) extreme (12) stratus (3) storm clouds (1) cumulonimbus (1)	move(ment) (30) gears (2) *push (33) pull (11) force (7) spin (4) machines (1) stop-motion movie (2) sequence (1) forward (9) backward (4) side-to-side (1) curve (3) demolition derby (2) guttering (2) two-finger push (32) predict(ion) (8) tread (7) grip (1) aerodynamic (1)	(not) living (33) photosynthesis (0) insect (1) unique (3) safe(ty) (20) protect (10) shelter (6) food (11) sun (11) near (2) qualities (1) traits (1) perch (1) grasslands (1) specific (1)

Note. This table lists target words and the number of times the teacher used each target word within the lesson (in parentheses), excluding instances in which target words were read aloud

from text. Derivations of target words are included in the count (e.g., *moving* as form of *move/movement*).

*This does not include *push* when used as part of the targeted term *two-finger push*.

In contrast, only one word is seemingly targeted for instruction in the *Teachers Pay Teachers* force and motion lesson, although this is done so implicitly. The activity description itself does not include an introduction of the word *friction*; however, one of the student sheets asks *Why does the car stop moving?* and the answer key identifies *friction* as the correct response. Further, the bottom of this student sheets states, "Things rubbing together create a force called friction. The car would keep moving if it were on a sheet of ice; there would be nothing to slow it down. The friction of the dirt against the wheels slow down the car." The following transcript shows Ms. Thompson introducing the term *friction* during the activity:

> Ms. Thompson: the bumps that are on the road, in real life, on our track, with the sand, on the carpet because the carpet is bumpy, cause a force that is called friction. [**Introduce Word, Use Target Word, Emphasize, Provide Example/Nonexample, Help Students Make Personal Connection**]
> *teacher emphasizes "friction"*
> Ms. Thompson: who has heard of that word before? [**Heard of Word**]
> *teacher makes the sign for making a connection/agreeing and some students copy*
> Ms. Thompson: friction is the force that slows things down. [**Use Target Word, Emphasize, Explain/Define**]
> *teacher emphasizes "friction" and "force" and "slows things down"*
> Ms. Thompson: slows things down. [**Explain/Define**]
> Ms. Thompson: if we rolled our matchbox cars across a table top, would they go smooth and fast or slow down?
> Child(ren): smooth and fast.
> Ms. Thompson: what if we took (th)em out to the playground on that big piece of ice that used to be out there.
> Ms. Thompson: would they slide smooth and fast or slow down?
> Ms. Thompson: smooth and fast.
> Ms. Thompson: because ice is so slippery smooth on top.
> *teacher spreads her hands out smoothly, as if on top of a surface of ice.*
> Ms. Thompson: what if we took one of our cars to the beach or the sandbox?

Ms. Thompson: how would they go there?
Child(ren): slow.
Ms. Thompson: I don't even think they'd move, would they? [**Use Target Word**]
Ms. Thompson: would they even move? [**Use Target Word**]
Child(ren): a little bit.
Child(ren): no.
Ms. Thompson: maybe.
Ms. Thompson: maybe hardly anything at all.
Child(ren): just like that much.
Ms. Thompson: Ben.
Ms. Thompson: hold your truck up, Ben, so we can look at it.
Ms. Thompson: Ben's treads also cause friction. [**Use Target Word, Provide Example/Nonexample**]
Ms. Thompson: but on that kind of truck, you want the friction because you want it to grab the ground. [**Use Target Word**]
Ms. Thompson: does that make sense?
Ms. Thompson: the kind of cars that have a tread like that, like tanks in the army that have to travel on dirt or sand. [**Use Target Word, Provide Example/Nonexample**]
Ms. Thompson: cars with little wheels would never work in the desert, would they?
Ms. Thompson: but cars with treads like Ben's would work great in the desert.
Ms. Thompson: Ben, bring me your car.
teacher is asking a student to give up his car because he is not using it appropriately.
Ms. Thompson: they would work great in the desert because they work with the friction. [**Use Target Word**]
Ms. Thompson: they work with the friction. [**Use Target Word**]

In this example, Mrs. Thompson introduced the term *friction*, providing examples and an explanation. She asked if students were familiar with the word and helped them make personal connections to it. She also used the word repeatedly, providing multiple exposures and drawing students' attention to it by emphasizing it at times. It is likely that Ms. Thompson's introduction of the term *friction* was influenced by it being the correct response, according to the answer key, to the student sheet accompanying the activity. Therefore, the inclusion of *friction* as a term

students should know by the time they complete the activity sheet seems to be related Ms. Thompson's enhanced vocabulary talk in connection to this term.

While Ms. Thompson, on her own, targeted an additional 20 words for instruction (see Table 5) by bringing students' awareness to them and their meanings, she engaged in the least vocabulary talk overall during this lesson (see Figure 12) compared to the other two video recorded lessons. With the exception of terms like *move(ment), push, pull,* and *two-finger push*, which were used a great number of times throughout the lesson, most of the terms Ms. Thompson introduced were briefly explained but not used throughout the lesson. For example, Ms. Thompson demonstrated the meaning of the term *grip* by making gripping motion with her hands while saying the word but did not use the term or explain its meaning further. Similarly, in the following example, Ms. Thompson briefly introduces the term *guttering* when setting up the track students would push their car down during the activity:

> Ms. Thompson: your car is going to travel down this track of this white stuff.
> *teacher is laying out a track made out of gutters in the center of a circle of students and continues to lay it out as she talks*
> Ms. Thompson: this is the kind of stuff that catches rain on the edge of your house. [**Explain/Define, Help Students Make Personal Connection**]
> Ms. Thompson: do you know what I'm talking about?
> Child(ren): no.
> Ms. Thompson: it's called guttering. [**Introduce Word, Use Target Word, Provide Visual Support**]
> Ms. Thompson: say that word. [**Ask to Repeat**]
> Child(ren): guttering.
> Ms. Thompson: guttering. [**Use Target Word**]
> Ms. Thompson: yep.
> Ms. Thompson: it catches the rain and makes the rain flow off your roof. [**Explain/Define, Help Students Make Personal Connection**]
> Ms. Thompson: but we are using it for science.

In this example, Ms. Thompson introduced the term *guttering*, used it repeatedly, provided visual support, and explained/defined what it is and what it does. She helped students make personal

connections and asked students to repeat the word. However, after this brief episode, the term is not used again and does not seem essential to the activity. Likewise, many of the terms Ms. Thompson targeted for instruction on her own during this lesson were introduced in passing in this way, including *machine, sequence, demolition derby,* and *side-to-side*. Therefore, while Ms. Thompson brought students' awareness to these terms and their meanings (i.e., making them target words), she did not engage in the kind of sustained vocabulary talk that often accompanied the terms that (a) were identified for instruction, (b) had child-friendly definitions, and (c) had marked places in the lesson for introduction and/or review by the *SOLID Start* materials.

The *Mystery Science* Plant and Animal Secrets lesson did not identify any words to be introduced or reviewed/reinforced. While this does not mean that Ms. Thompson could not engage in vocabulary talk, the data shows that she engaged in considerably less vocabulary talk during this lesson than during the *SOLID Start* lesson (see Figure 12). The vocabulary talk that Ms. Thompson did engage in during the *Mystery Science* lesson was all based on words that she herself targeted for instruction by bringing students' awareness to them and their meanings, such as *(not) living, safety,* and *protect*. Many of these terms were briefly explained in passing, without in-depth discussion of their meaning. For example, Ms. Thompson briefly reviews the meaning of the word *photosynthesis* when a student offers it a response to a question regarding what all living things need:

> Child(ren): photosynthesis.
> Ms. Thompson: what is that? [**Elicit Student Ideas: Review Word**]
> Ms. Thompson: tell me more about that big kid word. [**Elicit Student Ideas: Review Word**]
> Ms. Thompson: do you remember what it means? [**Elicit Student Ideas: Review Word**]
> Ms. Thompson: good job remembering that long word. [**Praise**]
> Ms. Thompson: can someone //
> Ms. Thompson: do you want someone to help you out, David?
> Ms. Thompson: remembering what it means?
> Ms. Thompson: you remembered the word. [**Acknowledge Student Ownership**]

Ms. Thompson: let's see if somebody else remembers what it means.
Ms. Thompson: Eleanora, do you remember what it means? [**Acknowledge Student Ownership**]
Child(ren): that plants get food from the sun.
Ms. Thompson: plants make their own food. [**Explain/Define**]
Ms. Thompson: but they need the sun to make their own food. [**Explain/Define**]
Ms. Thompson: great connection.
Ms. Thompson: way to work together friends.
Ms. Thompson: okay today, we're going to do a new lesson in *Mystery Science* where we talk about living things and something new about them. [**Use Target Word, Emphasize**]
teacher emphasizes "living things"

In this example, Ms. Thompson briefly supported students in connecting the term *photosynthesis* to the idea that plants make food with the help of the sun. This discussion was over rather quickly, likely because the word *photosynthesis* was only loosely connected to the topic of the lesson. Notably, Ms. Thompson did not use the term *photosynthesis* herself or engage students in the discussion beyond quickly reviewing its meaning. In another example from this lesson, Ms. Thompson briefly reviews the word *perch* while holding up covers of books the class had previously read and discussing where the animal on the cover finds its home:

Ms. Thompson: does anyone remember that special word they called for the stick? [**Prompt Word**]
Ms. Thompson: I'll give you a hint.
Ms. Thompson: it starts with /p/. [**Prompt Word**]
Ms. Thompson: what was it Elizabeth? [**Prompt Word**]
Child(ren): perch.
Ms. Thompson: perch. [**Review Word, Use Target Word**]

In this example, Ms. Thompson prompted students to use the word *perch* one time. It is evident that this word was previously introduced—most likely when the text was originally read. This review again happened quickly and the word was only loosely connected to greater lesson, as was the case with the words *insect, unique, near*, *qualities*, *traits*, *grasslands*, and *specific*.

The words Ms. Thompson targeted for instruction that received more attention during the *Mystery Science* lesson (i.e., *(not) living, protect, safe(ty), shelter, food, sun*) were all more

closely connected to the lesson topic: *Where do animals live?* Ms. Thompson engaged in more vocabulary talk surrounding these terms. In the following example, Ms. Thompson reviews the meaning of the word *safety*:

Ms. Thompson: what does it mean? [**Elicit Student Ideas: Review Word**]
Ms. Thompson: what does safety mean? [**Use Target Word, Emphasize, Elicit Student Ideas: Review Word**]
teacher emphasizes the word "safety"
Ms. Thompson: it's hard to put in words.
Ms. Thompson: like we know in our mind what it means.
Ms. Thompson: but if you put it in words, what would you say? [**Elicit Student Ideas: Review Word**]
Ms. Thompson: safety means... [**Use Target Word, Elicit Student Ideas: Review Word**]
Ms. Thompson: let's see, um, Kaitlin.
Child(ren): um /
Ms. Thompson: it means... [**Elicit Student Ideas: Review Word**]
Child(ren): that um, like, um, if, um, like, if you're home and your mom was in the shower, and then, and then you /
Ms. Thompson: but what does safety mean? [**Use Target Word, Elicit Student Ideas: Review Word**]
Child(ren): that you gotta, um, like, go somewhere safety.
Ms. Thompson: okay.
Ms. Thompson: wanna add to that, Charlie?
Child(ren): um, it's about, um, the, the spiders in /
Ms. Thompson: okay but we're talking about safety right now. [**Use Target Word, Emphasize**]
teacher emphasizes the word "safety"
Ms. Thompson: thank you.
Ms. Thompson: how would you describe what safety means? [**Use Target Word, Elicit Student Ideas: Review Word**]
Ms. Thompson: Maddie, what do you think? [**Elicit Student Ideas: Review Word**]
Child(ren): xxx a place to stay xxx so you can feel like xxx.
Ms. Thompson: it's a place where you can stay where you feel what? [**Elicit Student Ideas: Review Word**]
Child(ren): safe.
Ms. Thompson: safe. [**Use Target Word, Emphasize**]
teacher emphasizes the word "safe"
Ms. Thompson: another word? [**Elicit Student Ideas: Review Word**]
Ms. Thompson: comfy. [**Explain/Define**]
Child(ren): live.
Ms. Thompson: live. [**Use Target Word**]
Child(ren): cozy.
Ms. Thompson: cozy. [**Explain/Define**]

Ms. Thompson: how about protected? [**Suggest Word/Phrase, Review Word, Use Target Word, Emphasize, Explain/Define**]
teacher emphasizes the word "protected"
Child(ren): yes.

In this example, Ms. Thompson elicited students' ideas about the meaning of the word *safety*, which was difficult for them to explain. After students eventually offered *comfy* and *cozy* as explanations, Ms. Thompson suggested the word *protected*. Ms. Thompson commented that *safety* is a hard word to explain, which points to the usefulness of child-friendly, curriculum-provided explanations. Because no words were targeted for instruction within this *Mystery Science* lesson, Ms. Thompson did not have access to a child-friendly definition from the curriculum.

Although Ms. Thompson engaged in some vocabulary talk with a few terms she targeted for instruction on her own, this is considerably less vocabulary talk than she engaged in when targeted words were identified in the curriculum. This suggests a relationship such that using curriculum materials that target specific vocabulary words to be introduced and/or reviewed/reinforced is associated with Ms. Thompson's enhanced vocabulary talk, while not using curricular materials that identify words to target for instruction is associated with considerably less vocabulary talk.

Texts and Supports for Extra-Textual Talk

Text selection and prompts provided to support extra-textual talk (i.e., the talk that happens around the text) (Biemiller & Boote, 2006; National Institute of Child Health and Human Development, 2000; Wright, 2018) also seemed to be related to enhanced vocabulary talk for Ms. Thompson. Children are exposed to words through text and through talk; therefore, it makes sense that the texts and supports for talk around these texts would be related to enhanced vocabulary talk. The *SOLID Start* lesson identifies two excerpts from trade books to be

read, which highlight specific vocabulary terms that have been targeted for instruction within the lesson. For example, the two-page excerpt from *What Is Precipitation?* (Johnson, 2013) is used to introduce the terms *flood* and *snowstorm.* The text provides both written explanations of these terms and photographs of a flood and snowstorm. Additionally, the *SOLID Start* Weather Forecasting lesson supports extra-textual talk with the following prompts:

- Page 14: *A **flood** is when too much rain falls in a short time and the water does not soak into the ground.* Have the students repeat the word. Show them the picture of the flood in the book. *Could you play outside in a flood?*
- Page 15: *A **snowstorm** is when a lot of snow falls in a short time.* Have students repeat the word. *Do snowstorms ever happen where we live?*

These supports for extra-textual talk promote vocabulary talk by encouraging teachers to use specific moves. On each of these pages, the teacher is encouraged to use the target word, provide an explanation/definition, ask students to repeat the word, and help students make a personal connection. The prompt for page 14 also encourages the teacher to draw the students' attention to the photograph of a flood, thereby providing visual support for the term. The following transcript shows how Ms. Thompson engaged in vocabulary talk while reading this excerpt:

> Ms. Thompson: look at this severe weather. [**Use Target Word, Emphasize, Provide Visual Support**]
> *teacher is pointing to a picture in a book that she is projecting up on the SMARTBoard and emphasizes "severe" as she says it*
> Ms. Thompson (reading text): sometimes a lot of precipitation falls in a very short period of time.
> Ms. Thompson (reading text): when too much rain falls, there may be floods.
> Ms. Thompson: a flood /
> Child(ren): what's a flood?
> Ms. Thompson: a flood is when too much rain falls and there's kind of nowhere for it to go. [**Introduce Word, Use Target Word, Explain/Define, Provide Visual Support, Answer a Question**]
> *teacher is gesturing to a picture of a flood projected on the SMARTBoard*
> Ms. Thompson: that's extreme weather. [**Use Target Word, Emphasize**]

teacher emphasizes "extreme"

Ms. Thompson: do you agree?

Child(ren): mm-hmm.

Ms. Thompson (reading text): floods can happen when rivers or lakes get too full and the water flows out over the land that is usually dry.

Ms. Thompson (reading text): floods can happen very quickly so it is best to stay away from rivers or lakes when it's raining very hard.

Child(ren): or if there's sharks or alligators in it.

Ms. Thompson: this was us a couple days ago. [**Help Students Make Personal Connection**]

teacher is gesturing to a picture with a lot of snow

Child(ren): oh my god!

Ms. Thompson (reading text): when a lot of snow falls in a short time, it is called a snowstorm.

Ms. Thompson (reading text): snowstorms can bury roads and sidewalks and cars under thick layers of snow.

Ms. Thompson (reading text): the snow makes it hard for people to get from place to place.

Ms. Thompson (reading text): heavy snow can also damage buildings and trees.

Ms. Thompson: this is what it looked like outside on Monday. [**Help Students Make Personal Connection, Provide Visual Support**]

teacher is gesturing to the same picture, where snow covers cars, trees, and houses

Ms. Thompson: this is why we didn't have school on Monday, because there was just too much snow on the roads. [**Help Students Make Personal Connection**]

Ms. Thompson: <couldn't drive!> [**Help Students Make Personal Connection**]

Child(ren): <and on cars.>

Ms. Thompson: too much. [**Help Students Make Personal Connection**]

Ms. Thompson: there was a snowstorm. [**Introduce Word, Use Target Word, Emphasize, Help Students Make Personal Connection**]

teacher emphasizes "snowstorm"

Ms. Thompson: what was there? [**Ask to Repeat**]

Child(ren): snowstorm.

Ms. Thompson: too much snow, snowstorm. [**Use Target Word, Emphasize, Explain/Define**]

teacher emphasizes "snowstorm"

Child(ren): <there's been a lot of snowstorms lately.>

Child(ren): <xxx.>

Ms. Thompson: we did. [**Help Students Make Personal Connection**]

Ms. Thompson: too much rain, what's that called? [**Prompt Word**]

teacher is gesturing to the same picture of the flood used before

Child(ren): floods.

Ms. Thompson: flood. [**Use Target Word, Emphasize**]

teacher emphasizes "flood"

This transcript shows that Ms. Thompson engaged in vocabulary talk around this text by explaining the target words *flood* and *snowstorm,* prompting students to say these words aloud, drawing attention to the visual supports provided by the photographs depicting the meaning of the words, and helping students make personal connections based on their shared recent experiences with snowstorms. She also drew attention to *flood* and *snowstorm* saying them with emphasis. In other words, Ms. Thompson took up and built upon the supports for extra-textual talk provided within the lesson. This suggests that the use of texts to introduce and/or reinforce targeted vocabulary and the provision of supports for extra-textual talk are related to enhanced vocabulary talk.

In contrast, the *Teachers Pay Teachers* activity does not include any text, and the *Mystery Science* lesson uses a digital text (*Who Lives There?* by Pat Murphy) that appears to have been created for the lesson. Although the *Mystery Science* lesson overview indicates that the focus of the lesson is on the animal need of shelter and the "Activity Prep" description indicates students will learn about squirrels' habitats, the terms *shelter* and *habitat* are not included in the text. Similarly, no science vocabulary words are identified to be introduced alongside the text, as no words are targeted for instruction within the lesson. Further, the supports for extra-textual talk do not promote vocabulary talk. The lesson identifies just one point in the read-aloud to pause for discussion, with the prompts: *Which animal do you think lives up there? Why do you think that?* The adjacent page shows a photograph of a nest high up in a tree. Below the nest are photographs of a squirrel, deer, and turtle, with arrows pointing from each animal to the nest. Above the nest is a question mark. The following transcript shows the discussion of the given prompts:

> Ms. Thompson (reading text): which animal //
> Ms. Thompson: look at your choices: squirrel, deer, or turtle.

Ms. Thompson (reading text): which animal lives up there?
Child(ren): squirrel.
Child(ren): well deer can eat acorns too.
Ms. Thompson: deer can eat acorns.
Child(ren): but it's like, but it's probably squirrel (be)cause it's a nest.
Ms. Thompson: okay.
many students speak at once
Ms. Thompson: okay, hold on a second.
Ms. Thompson: let's take a look //
Ms. Thompson: let's think about what Lydia just said.
Ms. Thompson: she said deer like to eat acorns.
Ms. Thompson: but it's a nest.
Ms. Thompson: and it's up high.
Ms. Thompson: so why would that not work for a deer?
Child(ren): because a deer would have to have suction cups to climb up but it's fantasy /
Ms. Thompson: but we're not talking fantasy.
Ms. Thompson: today we're talking realism.
Ms. Thompson: today we're talking realism.
Ms. Thompson: so can deer climb a tree, Name?
Ms. Thompson: no.
Ms. Thompson: no.
Ms. Thompson: anybody have something else they want to share?
Ms. Thompson: how //
Ms. Thompson: Name, what do you think?
Child(ren): a squirrel can climb trees because if a deer would climb a tree it would go /woo/ and it would fall, it would keep falling down.
student makes falling gesture with hand while making /woo/ sound effect
Ms. Thompson: it doesn't have any tools on its body to help it climb a tree, does it?
Child(ren): only a squirrel does.
Ms. Thompson: only a squirrel does.
Ms. Thompson: of these three choices.
Ms. Thompson: of these three choices.
Ms. Thompson: yes, Name?
Child(ren): a turtle can climb a tree but they don’t xxx really hard for them to climb trees but turtles could climb—I bet turtles could climb xxx than a deer.
Ms. Thompson: you think a turtle could do a better job than a deer.
Ms. Thompson: but I have never //
Ms. Thompson: have you ever seen a turtle climb a tree?
Child(ren): no.
Ms. Thompson: I don't know if their legs, um //
Ms. Thompson: look how teeny and short their legs are.
Ms. Thompson: I'm not sure those are good climbing legs.
Child(ren): they could stick their claws into each one.
Ms. Thompson: maybe.
Ms. Thompson: maybe.
Child(ren): it would be so slow though.

Ms. Thompson: do you think their shell is heavy?
Child(ren): yes.
Ms. Thompson: that might make it hard for them to climb.
Ms. Thompson: do you think a squirrel's fur is heavy?
Child(ren): no.
Ms. Thompson: no, I don't think so either.
Ms. Thompson: so maybe it makes it better for them to, to climb a tree.
Ms. Thompson: let's keep going.
Ms. Thompson (reading text): I think I'll watch that clump of leaves for a while.

This transcript shows that the discussion prompts provided to support extra-textual talk did not support vocabulary talk, as Ms. Thompson did not use any vocabulary talk moves during this discussion. In fact, throughout the entire interactive read-aloud, Ms. Thompson used only one vocabulary talk move in one utterance. This finding suggests that the absence of (a) texts that introduce or review science vocabulary and (b) curricular supports for extra-textual talk that encourage teachers to use vocabulary talk moves is related to considerably less vocabulary talk than when these features are present.

Discussion Prompts

Discussion prompts that include words targeted for instruction and/or engage students in active processing also seem to be associated with enhanced vocabulary talk for Ms. Thompson. The *SOLID Start* lesson provides 36 prompts for teachers to draw from when facilitating discussions throughout the lesson. Most of these prompts include a word that has been targeted for instruction (e.g., *What are some examples of* ***severe*** *weather you are familiar with?*) and/or engage students in actively processing a word's meaning and developing understanding of its underlying concept (e.g., *In what types of precipitation is it safe to play outside?* to contrast the idea of severe weather). These discussion prompts provide opportunities for teachers to engage in vocabulary talk. For example, the *SOLID Start* lesson encourages teachers to facilitate a discussion in which students consider what they need to be prepared for when there is severe

weather and precipitation. As part of this discussion, Ms. Thompson asks a variation of the sample discussion prompt that was provided in the lesson (i.e., *What do we need to think about if there is a tornado?*):

Ms. Thompson: and what do we do at school to prepare, or get ready, in case there's a tornado? [**Use Target Word, Emphasize, Use with Hint, Visually Display Word, Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]
teacher holds up the whiteboard with "prepare" written on it; teacher emphasizes "prepare"
Ms. Thompson: what do we do? [**Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]
Child(ren): stay inside.
Ms. Thompson: we stay inside. [**Provide Example/Nonexample, Help Students Make Personal Connection**]
Child(ren): xxx
Ms. Thompson: get //
Ms. Thompson: well we don't get groceries at school. [**Help Students Make Personal Connection**]
Ms. Thompson: but what do we do when have our tornado drill? [**Use Target Word, Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]
Child(ren): have a...
Ms. Thompson: where do we go? [**Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]
Ms. Thompson: what do we do? [**Elicit Student Ideas: Example/Nonexample, Help Students Make Personal Connection**]
Child(ren): a strong, a strong building.
students are talking over themselves and the teacher as she asks her questions
Ms. Thompson: we're in a strong building. [**Provide Example/Nonexample, Help Student Make Personal Connection**]
Ms. Thompson: we go out to the hallway. [**Provide Example/Nonexample, Help Student Make Personal Connection**]
Ms. Thompson: we kneel down on our knees. [**Provide Example/Nonexample, Help Student Make Personal Connection**]
Ms. Thompson: show me what we look like. [**Help Student Make Personal Connection**]
students kneel down in tornado position
Ms. Thompson: kneel down on your knees. [**Help Student Make Personal Connection**]
Ms. Thompson: tuck your head down. [**Help Student Make Personal Connection**]
Ms. Thompson: and put your hands over the top of your head. [**Help Student Make Personal Connection**]

In this example, Ms. Thompson reviewed the meaning of the word *prepare* (a target word) and elicited examples from students of ways they prepare for tornadoes (another target word). She helped students make personal connections to each of these target words by asking them to consider their own experiences with preparing for tornadoes at school through participating in tornado drills. This example shows the relationship between discussion prompts that include target words and aim to develop students' understanding of their underlying meanings and Ms. Thompson's enhanced vocabulary talk.

In contrast, the *Teachers Pay Teachers* activity provides no discussion prompts, and the *Mystery Science* lesson provides only five discussion prompts, with two of them appearing within the read-aloud text (as previously described). The remaining three discussion prompts are found within the optional lesson extension, which involves watching a one-minute video and discussing the given prompts. These prompts are not related to any science vocabulary terms (as there are no words targeted for instruction within this lesson):

- *What animals did you see in the video?*
- *Where do the animals live? How do you know?*
- *If the animals could talk, what would you ask them?*

Ms. Thompson showed the video provided within the *Mystery Science* lesson and another video not listed within the curriculum. The following transcript shows part of the discussion Ms. Thompson's class had about what animals they saw in the two videos and where they live:

> Ms. Thompson: okay so what I wanted to talk about are the things that we saw in that video.
> Ms. Thompson: give me an example of one animal you saw and where it made its unique // [**Review Word, Use Target Word, Emphasize**]
> *teacher emphasizes "unique"*
> Ms. Thompson: what does unique mean? [**Use Target Word, Elicit Student Ideas: Review Word**]
> CHI: special.

Ms. Thompson: special. [**Explain/Define**]
CHI: in their own way.
Ms. Thompson: in their own way. [**Explain/Define**]
Ms. Thompson: different. [**Explain/Define**]
Ms. Thompson: special to just one thing. [**Explain/Define**]
Ms. Thompson: good.
Ms. Thompson: okay, raise your hand if you can think of an example of something we saw //
Ms. Thompson: thank you.
teacher is speaking to students who have already raised their hands
Ms. Thompson: something we saw and where it had its unique home. [**Use Target Word, Emphasize**]
teacher emphasizes "unique"
Ms. Thompson: Micah, give me one example.
Ms. Thompson: I saw...
Child(ren): the, the turtle in the fire desert.
Ms. Thompson: where does it make its home?
Ms. Thompson: there was a turtle.
Ms. Thompson: and it's in a place that catches fire.
Ms. Thompson: so where does it make its home?
Child(ren): in the ground.
Ms. Thompson: why?
Child(ren): because the fire burns xxx place /
Ms. Thompson: it's a protected place.
Child(ren): and because um, because um, fire can't get underneath ground.
Ms. Thompson: great.

In this example, Ms. Thompson engaged in some vocabulary talk around the word *unique*, which she reviewed here even though it was not identified within the *Mystery Science* lesson for introduction or review and reinforcement. Ms. Thompson does use some vocabulary talk moves when reviewing the meaning of *unique*; however, little vocabulary talk follows in the duration of this discussion. This suggests that discussion prompts that are not related to targeted vocabulary words are associated with less vocabulary talk.

Summary of Findings

This analysis shows an association between enhanced vocabulary talk by Ms. Thompson and using science curriculum materials that (a) identified target words and provided child-friendly explanations/definitions, (b) selected texts highlighting these target words and provided

supports for extra-textual talk promoting vocabulary talk, and (c) offered discussion prompts for deepening students' understandings of target word meanings. Likewise, this analysis showed that the absence of these curricular features is associated with less vocabulary talk. This study suggests that while science instruction *can* offer a rich context for oral language and vocabulary development (e.g., Gotwals & Wright, 2017; Wright & Gotwals, 2017; Wright & Neuman, 2014), without high-quality curricular materials with features that enhance teachers' vocabulary talk, the potential of this context for promoting oral language and vocabulary development may not be realized.

CHAPTER 6—DISCUSSION, IMPLICATIONS, AND CONCLUSIONS

Discussion

The purpose of this dissertation study was to examine the ways in which teachers use language to promote oral language and vocabulary development during science instruction in the early-elementary grades. This is critical because, while oral language and vocabulary development support students' literacy *and* science learning (e.g., Anderson & Freebody, 1981; Guthrie et al., 1999; Mercer et al., 2004; Richmond & Striley, 1996; Senechal et al., 2006; Wang & Herman, 2006; Wright & Gotwals, 2017) and national standards place emphasis on oral language and vocabulary development (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010; NGSS Lead States, 2013), little is known about how teachers promote oral language and vocabulary development during science instruction in the early-elementary grades. It is important to understand what opportunities students have to develop oral language and also access science content, as both support literacy and science learning. Therefore, I conducted two instrumental case studies (Barone, 2011; Stake, 2000) to examine teachers' vocabulary talk during science instruction in early-elementary classrooms.

In the first study, I examined the science instruction of a cohort of eight early-elementary teachers in order to determine (1) how they used language to promote students' oral language and vocabulary development and (2) whether vocabulary talk is related to the language aspects of science talk, and if so, how. I used discourse analysis techniques to analyze 24 video recorded science lessons (894.27 minutes of observational data) across three timepoints from the eight participating teachers. I then used quantitative techniques to make within- and between-teacher comparisons of vocabulary talk over the course of the study. I found that the cohort of teachers

used all four types of vocabulary talk (i.e., *Knowledge & Understanding*, *Affective Factors*, *Student Word Use,* and *Metalinguistic & Metacognitive Awareness*) during science instruction; however, the cohort as a whole engaged in considerably more *Knowledge & Understanding* vocabulary talk (i.e., 86.72%) than any other type of vocabulary talk. This was also reflected in the vocabulary talk of individual teachers, with a few exceptions when teachers did not engage in any vocabulary talk or made only one vocabulary talk move during a lesson. Between-teacher comparisons show no consistent patterns in teachers' vocabulary talk over time. In examining the relationship between vocabulary talk and the language aspects of science talk, I found that there appears to be a relationship between *Knowledge & Understanding* vocabulary talk and science talk focused on building knowledge of science oral language (as measured by Domain 3, Component 1 of the SOLID Start Tool); however, further research is needed to examine whether there is a relationship between *Student Word Use* vocabulary talk and science talk focused on scaffolding students' word use language (as measured by Domain 3, Component 2 of the SOLID Start Tool). Further, my analysis points to the need to consider the context in which vocabulary talk moves are made and the overall quality of this vocabulary talk in addition to examining which moves the teachers make and how frequently they make them.

In the second study, I examined the science instruction of Ms. Thompson, a kindergarten teacher, in order to identify what features of science curriculum materials are related to enhanced vocabulary talk. I used qualitative analysis techniques to analyze three video recorded science lessons (128.03 minutes of observational data) alongside the curricular materials from which Ms. Thompson drew for these lessons. I found that using science curriculum materials that (a) identified target words and provided child-friendly explanations/definitions, (b) used texts that highlight these target words and provided supports for extra-textual talk promoting vocabulary

talk, and (c) offered discussion prompts that deepen students' understandings of target word meanings was associated with enhanced vocabulary talk by Ms. Thompson. Likewise, I found that the absence of these curricular features was associated with less vocabulary talk.

In the following sections, I discuss these findings in relation to the empirical and theoretical literature on how children learn words.

Types of Vocabulary Talk

The cohort of early-elementary teachers in this study engaged in considerably more *Knowledge & Understanding* talk than any other type of vocabulary talk. This finding reflects the focus of the research literature on how children learn words, as far more studies have explored instructional practices for building students' knowledge of word meanings than scaffolding students' word use, building students' awareness of words and word learning, or interesting students in words and word learning. However, most of the studies that comprise the research base on how children learn words examined vocabulary instruction within the context of literacy instruction (e.g., Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; Hadley et al., 2019; McKeown & Beck, 2003; Silverman, 2007a, 2007b; Silverman & Crandell, 2010; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014). Importantly, the present study shows that this cohort of early-elementary teachers used language in many ways that are aligned with the research on building students' knowledge of word meanings *during science instruction*. This is promising for both literacy and science learning in the early-elementary grades because this suggests that there are important opportunities for teachers to build students' vocabulary knowledge across content areas. Given the sheer number of vocabulary words there are to learn (Anderson & Nagy, 1992; Nagy &

Anderson, 1984) and the need to learn discipline-specific vocabulary (Bravo & Cervetti, 2008), it is important to seize the opportunities for vocabulary learning across the elementary school day.

In addition to having the greatest percentage of the cohort's vocabulary talk, *Knowledge & Understanding* was also the type of talk with the most individual vocabulary talk moves (i.e., number of unique second-level codes). I identified 21 different vocabulary talk moves that align with the research on building students' knowledge of word meanings, compared to only six moves for interesting students in words and word learning (i.e., *Affective Factors*), six moves for scaffolding students' word use (i.e., *Student Word Use*), and one move for building awareness of words and word learning (i.e., *Metalinguistic & Metacognitive Awareness*). This may be because the research literature has focused primarily on building students' knowledge of word meanings; therefore, much is known about how to promote students' oral language and vocabulary development in this way.

Notably, the type of vocabulary talk used second most frequently after *Knowledge & Understanding* was *Affective Factors*. This is somewhat surprising, as this type of vocabulary talk is the least reflective of the research base. This type of vocabulary talk is based in the theory of word consciousness (e.g., Anderson & Nagy, 1991, 1992; Graves, 2000, 2006; Graves & Watts-Taffe, 2002, 2008; Nagy & Scott, 2000; Scott & Nagy, 2004), and to my knowledge, only one study has examined the specific impact of word consciousness instruction on students' vocabulary development. Neugebauer et al. (2017) investigated the impact of teachers' *word consciousness talk* on kindergarten students' general vocabulary knowledge. They identified three specific talk moves—reinforcing students' word use, affirming students' recognition of word meanings, and helping students make personal connects to words—and found that these moves were positively associated with gains in students' general vocabulary knowledge at the

end of the school year. In the present study, the cohort of teachers used two of these moves—reinforcing students' word use (i.e., PRAISE) and helping students make personal connections to words (i.e., HELP STUDENTS MAKE PERSONAL CONNECTIONS). They also used four additional *Affective Factors* moves that align with the research on interesting students in word and word learning. When students showed curiosity about a word's meaning, the teachers answered their questions. At times, the teachers celebrated students' word use by acknowledging their "ownership" of words. Infrequently, teachers also modeled appreciating words/word choice and enjoying favorite words. While it is promising that the cohort of teachers engaged in this kind of *Affective Factors* talk, across the data set, this talk accounted for only 7.85% of total vocabulary talk code applications. This suggests that interesting students in words and word learning was not a primary focus of the teachers' vocabulary instruction during science lessons. In order to provide more empirical support for this primarily theoretical type of vocabulary talk, further research is needed to examine the relationship between *Affective Factors* vocabulary talk moves and students' oral language and vocabulary development.

Another type of vocabulary talk with relatively few code applications (i.e., 5.23% of total vocabulary talk code applications) was *Student Word Use*. This may be reflective of the common finding in observational studies that teachers do most of the talking within a classroom (e.g., Nystrand, 2006; Silverman et al., 2014). In an observational study of vocabulary instruction at the elementary level, Silverman et al. (2014) found that 75% of utterances across all lessons were teacher utterances, and these utterances were more than four times as long as student utterances, on average. The present study captured what students said in order to provide context for teacher utterances but did not record student speech at the level of the utterance; therefore, it is not possible to determine the percentage of utterances that were teacher talk compared to student

talk. However, it was evident that the cohort of teachers did more talking than their students. With limited opportunities for students to talk, there were also limited opportunities to use target vocabulary. The finding that teachers used little *Student Word Use* talk is consistent with the overall trend for Domain 3 Component 2 scores on the SOLID Start Tool (i.e., measuring the language aspects of science talk focused on scaffolding students' word use). Of the 24 lessons observed in the present study, only 10 had composite scores at or above 3.0 for this component, meaning that 14 lessons scored below Medium for scaffolding students' use of previously-introduced discipline-specific oral language (Wright et al., 2017). Together, these low scores for the language aspect of science talk focused on scaffolding students' word use and the lack of vocabulary talk moves encouraging students to use target words suggests that scaffolding students' use of target words was not a focus of the teachers' vocabulary instruction during science lessons. Given that studies have found scaffolding students' word use to promote oral language and vocabulary development (e.g., Beck & McKeown, 2001, 2007; Coyne et al., 2007, 2009, 2010; Juel & Deffes, 2004; McKeown et al., 1983, 1985; McKeown & Beck, 2003; Rosenthal & Ehri, 2011; Silverman, 2007a; Silverman & Crandell, 2010; Zipoli et al., 2011), this lack of scaffolding students' word use highlights an area for professional development.

Finally, there was only one *Metalinguistic & Metacognitive Awareness* vocabulary talk move across the entire data set—asking students if they had heard of a word—and it accounted for only 0.20% of total vocabulary talk code applications. This may be reflective of the research base, as building students' awareness of words and word learning is well researched, but much of this work has focused on upper-elementary and intermediate grades (e.g., Baumann et al., 2002, 2003; P. N. Bowers & Kirby, 2010; Lesaux et al., 2010; Lubliner & Smetana, 2005; Zipke, 2007, 2008; Zipke et al., 2009). Only a few of the studies examining instruction focused on developing

metalinguistic and metacognitive awareness have taken place within the context of early-elementary classrooms (i.e., K-2) (e.g., Cain, 2007; Freeman et al., 2019; Nash & Snowling, 2006; Wise, 2019). Nash and Snowling (2006) compared instruction in which 7- and 8-year olds were taught the meanings of target words with instruction in which they were taught to look for context clues to derive the meaning of target words. They found that three months after the intervention, students in the context instruction condition showed significantly better expressive vocabulary, comprehended text containing target words significantly better, and could independently derive word meanings from written context. This study suggests that building early-elementary students' awareness of words and word learning may have a greater impact on vocabulary development than merely focusing on buildings students' knowledge of specific word meaning. Similarly, Wise (2019) examined the effects of an intervention designed to teach second-grade students to use four types of context clues (i.e. synonyms, pictures, definitions, and antonyms), finding that students in the intervention condition significantly outperformed students in the business-as-usual comparison condition with the skill of noticing unfamiliar words. As Wise argued, this is an important step for supporting students in becoming independent word learners because it may support their incidental word learning from oral and written contexts. Relatedly, Cain (2007) examined whether explanation facilitated contextual analysis with 7- and 8-year-old students, finding that students who explained how a word was derived from context made the greatest gains in definition accuracy. Again, accurately deriving word meanings from context is important for supporting students in becoming independent word learners. Focusing instead on morphological instruction, Freeman et al. (2019) explored how three first-grade students responded to a small-group intervention with explicit instruction on Greek and Latin roots that was integrated with science vocabulary and texts. Freeman and colleagues found that

this instruction increased students' morphological awareness, as they were able to find roots in words and were developing the ability to analyze word features and look for clues to their meaning. These too are important skills for becoming independent word learners. Therefore, while only a few studies have examined instruction focused on developing early-elementary students' metalinguistic and metacognitive awareness, their findings point to the need for this kind of instruction in order to set young students on a path toward becoming independent word learners.

These studies focused on building students' metalinguistic and metacognitive awareness in the early-elementary grades (i.e., Cain, 2007; Freeman et al., 2019; Nash & Snowling, 2006; Wise, 2019) have been intervention studies that have intentionally focused on this approach to promoting oral language and vocabulary development. Like the present study, observational studies of vocabulary instruction have found limited focus on developing students' metalinguistic and metacognitive awareness. In particular, the lack of vocabulary talk moves in attending to morphology and syntax in the present study is consistent with other studies that have found limited instructional attention devoted to these aspects of word learning in the upper-elementary grades (e.g., Scott et al., 2003; Silverman et al., 2014; Watts, 1995). Likewise, the lack of vocabulary talk moves addressing contextual analysis is consistent with the lack of contextual analysis instruction observed by Silverman et al. (2014). Given that studies have found that metalinguistic and metacognitive awareness instruction promotes oral language and vocabulary development in the early-elementary grades (e.g., Cain, 2007; Freeman et al., 2019; Nash & Snowling, 2006; Wise, 2019), the consistent absence of this instruction in elementary classrooms points to the need for professional development focused on developing students'

metalinguistic and metacognitive awareness—including within science instruction in the early-elementary grades.

Quality of Vocabulary Talk

My analysis of the cohort of teacher's vocabulary talk in relation to the language aspects of science talk highlight the need to consider not only the vocabulary talk moves made by teachers but also the quality of the talk involved in each move. My analysis of vocabulary talk captured teacher talk that aligned with the research and theory on how children learn words—such as explaining or defining the meaning of a word. However, this analysis did not evaluate how well the vocabulary talk moves were executed—such as whether the explanation/definition used familiar words and concepts (i.e., child-friendly) to help students understand the new word. My analysis of the language aspects of science talk shows the discrepancy between quantity of vocabulary talk, as captured by rate of each type of vocabulary talk per minute, and quality of this talk, as captured by Components 1-2 of Domain 3 of the SOLID Start Tool (i.e., Talk that Develops Literacy and Language for Science). This distinction between quantity and quality of vocabulary talk is evident in Ms. Nelson's first lesson (i.e. PrePD), in which the weather terms students had learned so far in the *SOLID Start* Weather Forecasting unit were reviewed, but this was done as its own activity rather than within the context of science learning. Ms. Nelson engaged in a great deal of vocabulary talk and prompted her kindergarten students to use science oral language throughout the lesson. However, because this talk happened outside the context of science learning and because students were using science oral language to list words rather than to share their ideas, this lesson scored lower overall for science talk than for vocabulary talk. In other words, the context in which the vocabulary talk moves were made was not as rich as described in the research literature and therefore may not have been as impactful.

This distinction between quantity and quality of vocabulary talk is important because, for vocabulary talk moves to effectively promote students' oral language and vocabulary development, the quality of talk within a given move likely matters. In their observational study of vocabulary instruction during language arts instruction in third-, fourth-, and fifth-grade classrooms, Silverman et al. (2014) surprisingly found that the research-based practice of applying words in various contexts was negatively associated with change in vocabulary. Further analysis revealed that instruction that was coded as *application across contexts* sometimes led students off track and may have distracted them from the actual meaning of the word, such as when a teacher applied the target word *delivery* to the pizza delivery she had the night before and then the conversation turned to the foods students like to order rather than focusing on the delivery of those foods. Silverman and colleagues noted that while their study did not investigate the quality of instruction, future research should take this into consideration. Likewise, the present study points to the need for future research that takes quality of vocabulary talk moves into consideration—especially research that investigates the relationship between vocabulary talk moves and students' oral language and vocabulary development.

Further, while it has been common practice in vocabulary research to capture counts related to word learning (e.g., number of words, counts of different types of words, number of minutes of instruction, frequency of use of various instructional practices) (e.g., Barnes et al., 2017; Barnes & Dickinson, 2018; Hart & Risley, 2003; Scott et al., 2003; Silverman et al., 2014; Silverman & Crandell, 2010; Wright, 2014), the present study, like Silverman et al. (2014), shows the need to also take into consideration quality as it relates to these counts. Vocabulary research focused on the "word gap," for instance, has focused on comparing counts of how many words young children from various socioeconomic backgrounds have been exposed to by a

particular age (e.g., Hart & Risley, 2003). The present study suggests that such counts may not capture what is important in terms of promoting oral language and vocabulary development.

Curricular Supports for Vocabulary Talk

My analysis of features of science curriculum materials that are related to enhanced vocabulary talk was centered on one kindergarten teacher's science instruction across three lessons that drew from three different sets of curriculum materials; therefore, my findings cannot be generalized beyond this particular teacher and these particular lessons from these sets of curriculum materials. However, this analysis offers insight that may be particularly useful for developers of science curriculum materials. The identification of specific words to target for instruction within the lesson was associated with enhanced vocabulary talk; therefore, an important way curriculum materials may support students' vocabulary growth is by identifying words to introduce and review/reinforce within a lesson. Ms. Thompson engaged in far more vocabulary talk when the curriculum materials she used identified specific vocabulary words to introduce and review/reinforce, with the given child-friendly definitions, at specified points in the lesson (i.e., *SOLID Start* Weather Forecasting lesson). This is important because, while I coded any word that teachers targeted for instruction (by drawing students' attention to it and its meaning) as a target word—and therefore words outside of those identified by the curriculum materials could be target words—Ms. Thompson engaged in less vocabulary talk overall when it was up to her to identify words to target for instruction.

Many of the words Ms. Thompson targeted for instruction on her own were introduced briefly and then not revisited within the lesson, and often, these words were loosely related to the science content of the lesson (e.g., *gears, spin, machines, curve,* and *grip* in the *Teachers Pay Teachers* force and motion lesson) but were not central to communicating science

understandings from the lesson. This is consistent with Wright and Neuman's (2014) finding in their observational study of vocabulary instruction across the school day in kindergarten classrooms that teachers often gave one-time, brief word explanations with unsystematic word selection. In contrast, the words in the *SOLID Start* Weather Forecasting lesson that were targeted for introduction (i.e., *severe, flood, snowstorm, tornado, hurricane*) and review/reinforcement (i.e., *weather conditions, rain, snow, wind, fall, winter, spring, summer, cool, cold, warm, hot, prepare, measure, meteorologist, precipitation, thunderstorm*) were central to the lesson question (i.e., *How Can We Prepare for Severe Weather Conditions?*). Further, the words identified for instruction in the *SOLID Start* lesson are aligned with the research on teaching target words in conceptually- or semantically-related sets in order to promote students' knowledge of word meanings (e.g., Cervetti et al., 2016; Hadley et al., 2019; Neuman et al., 2011; Neuman & Dwyer, 2011; Neuman & Kaefer, 2013, 2018; Pollard-Durodola et al., 2011; Wasik et al., 2006; Wasik & Bond, 2001; Zipoli et al., 2011). The importance of the relationship between the target words for promoting vocabulary talk is evident in the transcripts from the *SOLID Start* lesson, as the density of vocabulary talk is greater throughout the lesson in comparison to the *Teachers Pay Teachers* and *Mystery Science* lessons with loosely related words discussed more sporadically here and there.

Two other features of science curriculum materials were associated with enhanced vocabulary talk by Ms. Thompson, but they were ultimately dependent on the curriculum materials having identified target words in the first place. The text selection and prompts for extra-textual talk in the *SOLID Start* lesson highlighted specific vocabulary terms that had been targeted for instruction, providing written explanations and photographs for visual support. This text selection provided a rich context for vocabulary talk, aided by the discussion prompts

provided in the lesson to support extra-textual talk. That the read-aloud context enhanced Ms. Thompson's vocabulary talk is unsurprising, as many studies of vocabulary instruction have been situated within read-alouds due to the rich context they provide for word learning (e.g., Barnes & Dickinson, 2018; Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; Dickinson & Smith, 1994; Dickinson & Tabors, 1991; Hadley et al., 2019; McKeown & Beck, 2003; Silverman, 2007a, 2007b; Silverman & Crandell, 2010; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014). In contrast, the *Teachers Pay Teachers* lesson did not include text, and the *Mystery Science* lesson included text but did not use that text to highlight any science vocabulary—as no words had been targeted for instruction within the lesson. The opportunity was there for the *Mystery Science* text to highlight terms such as *shelter* and *habitat*; however, the text selected (i.e., created) for this lesson does not include these terms, the lesson itself does not target these terms for instruction, and Ms. Thompson did not introduce these terms on her own. The absence of texts and extra-textual talk highlighting target words was related to considerably less vocabulary talk by Ms. Thompson.

Similarly, the discussion prompts provided throughout the *SOLID Start* lesson often included a target word or engaged students in actively processing a target word's meaning and developing understanding of its underlying concept. These prompts provided rich opportunities for Ms. Thompson to engage in vocabulary talk. This is unsurprising, as using target words and engaging students in deeper processing of target words is aligned with the research on how children learn words (e.g., Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; McKeown et al., 1983, 1985; McKeown & Beck, 2003; National Institute of Child Health and Human Development, 2000; Robbins & Ehri, 1994; Silverman, 2007a, 2007b; Silverman & Crandell, 2010; Stahl & Fairbanks, 1986; Wasik et al., 2016; Wasik &

Bond, 2001; Wasik & Hindman, 2014; Zipoli et al., 2011). In contrast, the *Teachers Pay Teachers* lesson did not provide any discussion prompts, and the *Mystery Science* lesson provided several prompts that did not use science vocabulary terms. Without having identified target words within the lesson, these discussion prompts did not provide opportunities for students to actively process target word meanings or develop understanding of their underlying concepts. The absence of discussion prompts related to target words was associated with less vocabulary talk by Ms. Thompson.

Beyond these specific curricular features, this analysis shows that the science curriculum materials teachers use matter in terms of supporting students' literacy and science learning. Science materials such as the *SOLID Start* curriculum seemingly set the stage for vocabulary talk and provide a rich context that develops students' language and literacy while deepening their science understanding. Such materials support coherence across lessons by identifying target words to review/reinforce as relevant to the current lesson, which provides multiple exposures to target words (e.g., Beck & McKeown, 2001; Biemiller & Boote, 2006; Coyne et al., 2010; National Institute of Child Health and Human Development, 2000; Stahl & Fairbanks, 1986) in multiple contexts (e.g., Beck & McKeown, 2001; Biemiller & Boote, 2006; Coyne et al., 2010; National Institute of Child Health and Human Development, 2000; Silverman et al., 2014; Stahl & Fairbanks, 1986; Wasik et al., 2016), often in conceptually- or semantically-related sets (e.g., Cervetti et al., 2016; Hadley et al., 2019; Neuman et al., 2011; Neuman & Dwyer, 2011; Neuman & Kaefer, 2013, 2018; Pollard-Durodola et al., 2011; Zipoli et al., 2011)—all of which is supported by the research base on how children learn words. What made Ms. Thompson's science instruction particularly interesting for further examination is that she taught three different lessons from three different sets of curriculum materials. From a curriculum analysis

perspective, this was helpful for analyzing curricular features across a variety of science curriculum materials. From a student learning perspective, however, this was likely not helpful for supporting either science or literacy learning, as these three lessons addressed different disciplinary core ideas from different branches of science—all within the span of just 12 weeks or so (i.e., PrePD videos were recorded before the 10-week SOLID Start usability trial began). Without following a single curriculum with coherent units of study, the opportunities to support students' oral language and vocabulary development across time were limited, as ideas and concepts that would repeat throughout coherent science materials—and therefore support vocabulary development—were not present.

Implications

The findings from this study have implications for curriculum development, teacher professional development, teacher preparation, and policy. In the following sections, I describe the implications for each area.

Curriculum Development

The present study highlights the need for science curriculum materials to identify words to target for instruction—both through introduction and review/reinforcement in subsequent lessons. These words need to be conceptually related (e.g., Cervetti et al., 2016; Hadley et al., 2019; Neuman et al., 2011; Neuman & Dwyer, 2011; Neuman & Kaefer, 2013, 2018; Pollard-Durodola et al., 2011; Wasik et al., 2006; Wasik & Bond, 2001; Zipoli et al., 2011) and central to supporting students' engagement with science learning (Wright et al., 2017). In addition to identifying target words, science curriculum materials should also provide child-friendly definitions or explanations of the meanings of these words (e.g., Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; McKeown et al., 1983, 1985;

McKeown & Beck, 2003; Nash & Snowling, 2006; Silverman, 2007a, 2007b; Silverman et al., 2014; Silverman & Crandell, 2010; Stahl & Fairbanks, 1986; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014). Texts that highlight these target words should be carefully selected and prompts should be given to support extra-textual talk during the reading of these texts. Finally, curriculum materials should also provide discussion prompts that use target words and provide opportunities for students to engage in deeper processing of these words (e.g., Beck & McKeown, 2001, 2007; Biemiller & Boote, 2006; Coyne et al., 2007, 2009, 2010; McKeown et al., 1983, 1985; McKeown & Beck, 2003; National Institute of Child Health and Human Development, 2000; Robbins & Ehri, 1994; Silverman, 2007a, 2007b; Silverman & Crandell, 2010; Stahl & Fairbanks, 1986; Wasik et al., 2016; Wasik & Bond, 2001; Wasik & Hindman, 2014; Zipoli et al., 2011). Science curriculum materials with these features provide rich contexts in which teachers can engage in vocabulary talk in order to promote students' oral language and vocabulary development while also deepening their science understandings.

Teacher Professional Development

The present study suggests that there may be a need for teacher professional development in the early-elementary grades regarding *Affective Factors*, *Student Word Use*, and *Metalinguistic & Metacognitive Awareness* vocabulary talk, as 86.72% of vocabulary talk code applications were for *Knowledge & Understanding* talk moves. Other studies have found limited instructional attention to *Student Word Use* and *Metalinguistic & Metacognitive Awareness* in particular (e.g., Scott et al., 2003; Silverman et al., 2014; Watts, 1995). While further research is needed to determine if there is a relationship between teachers' vocabulary talk moves and students' oral language and vocabulary development, the alignment of these vocabulary talk moves with the research on how children learn words makes it likely that teachers' vocabulary

talk impact students' word learning. Therefore, it is important for teachers to use language in ways that align with the full research base on how children learn words and not just on one type of vocabulary talk.

Teacher Preparation

Thinking of vocabulary instruction in terms of *Knowledge & Understanding, Student Word Use, Metalinguistic & Metacognitive Awareness*, and *Affective Factors* offers a four-part framework that could be useful for introducing preservice teachers to the tenets of vocabulary instruction. Teacher preparation programs should encourage preservice teachers to consider how they can promote students' oral language and vocabulary development through these types of vocabulary talk across the school day, as any time something new is learned is an opportunity for word learning (Wright, in press). Further, teacher preparation programs should emphasize the reciprocal relationship between literacy and science learning (e.g., Cervetti et al., 2012; Connor et al., 2017; Gotwals & Wright, 2017, 2017; Guthrie et al., 1999; Romance & Vitale, 1992, 2001; Varelas et al., 2006; Varelas & Pappas, 2006; Vitale & Romance, 2012; Wang & Herman, 2006) in both literacy and science methods courses so that beginning teachers enter the field understanding that science instruction provides a rich context for oral language and vocabulary development while building background knowledge—both of which ultimately support reading comprehension (Anderson & Freebody, 1981; Kintsch, 2013). Currently, much of the elementary curriculum is siloed (Wright & Domke, 2019), and little time is devoted to science instruction (Berliner, 2011; Blank, 2012); yet, it is not the case that taking time "from" literacy instruction for science lessons reduces literacy learning. Helping beginning teachers understand this from the start of their career has the potential to impact practice as they enter the field.

Policy

Just as it is important to teach preservice teachers about the reciprocal relationship between literacy and science learning (e.g., Cervetti et al., 2012; Connor et al., 2017; Gotwals & Wright, 2017, 2017; Guthrie et al., 1999; Romance & Vitale, 1992, 2001; Varelas et al., 2006; Varelas & Pappas, 2006; Vitale & Romance, 2012; Wang & Herman, 2006), it is important for policy makers to get this message as well. The cohort of eight teachers participating in this study reported spending 450-900 minutes on literacy instruction per week while spending only 30-90 minutes on science during this same timeframe. This cohort is not unique in this regard, as research has shown that little time is devoted to science instruction in elementary classrooms, while language arts and mathematics dominate the curriculum (Berliner, 2011; Blank, 2012). It is important for policy makers to understand that literacy learning is limited when students are not given the opportunity to develop oral language and vocabulary within the rich context provided by science instruction or to deepen science understandings that would provide valuable background knowledge—and both vocabulary knowledge and background knowledge play pivotal roles in students' reading comprehension (Anderson & Freebody, 1981; Kintsch, 2013). Therefore, focusing instructional time on literacy at the expense of science instruction for the purpose of promoting literacy learning, in reality, is to the detriment of both literacy *and* science learning.

In addition to creating policy that makes room for science instruction in the elementary curriculum, policy makers need to consider that the curriculum selected for teachers to use matters. While science instruction *can* offer a rich context for oral language and vocabulary development (e.g., Gotwals & Wright, 2017; Wright & Gotwals, 2017; Wright & Neuman, 2014), it is evident from the analysis of Ms. Thompson's science instruction that science

curriculum materials such as those found on *Teachers Pay Teachers* and the *Mystery Science* curriculum are not designed to promote students' oral language and vocabulary development while supporting their engagement with science learning. It is also evident from Ms. Thompson's teaching of the *SOLID Start* lesson that curriculum materials can set the stage for integrated vocabulary and science learning. Therefore, science curriculum materials should be carefully selected in order to best promote students' science *and* literacy learning.

Limitations

There are several limitations to this dissertation study. First, all eight of the teachers in the cohort participating in this study identified as White/European American females, and they primarily taught White/European American students (95.74% of students across the eight classes)—none of whom were learning English as an additional language. This limits the generalizability of my findings to other contexts, as the National Center for Education Statistics (2020) projected that 45.65% of students attending public schools in the United States would be White in 2019 and reported that 9.6% of students attending public schools in the United States were English Learners in 2016 (most recent data reported). Therefore, the students of the teachers participating in this study are not representative of the student population of schools in the United States, and the findings of this study cannot be generalized to the greater population.

The second limitation of this study is that I examined only one lesson from each of the three sets of science curriculum materials used by Ms. Thompson (i.e., *SOLID Start, Teachers Pay Teachers, Mystery Science*). It is possible that these particular lessons are not representative of the respective curriculum materials as a whole, and therefore, characterizations of these sets of curriculum materials are limited to the specific lesson analyzed from each and cannot be

extended to other lessons within these sets of curriculum materials without further analysis of additional lessons.

A third limitation of this study is that I did not interview the teachers after they taught their video recorded lessons in order to understand why they made the particular instructional decisions they made. This would have allowed me better understand how teachers were thinking about promoting oral language and vocabulary development. Specifically, I could have asked about the words they had planned to target for instruction and the words they targeted for instruction more spontaneously by bringing students' attention to them and their meanings. However, because this was an observational study of teachers' oral language and vocabulary use during science instruction, asking these questions could have altered the teachers' instruction in subsequent lessons.

Finally, as discussed in Chapter 3, perhaps the greatest limitation of the present study is that no student outcome data was collected. Like the present study, a number of observational studies of vocabulary instruction have not included student outcome data (Blachowicz, 1987; Dickinson et al., 2008; Nelson et al., 2015; Scott et al., 2003; Wanzek, 2014; Watts, 1995; Wright & Neuman, 2014); however, the absence of this information makes it impossible to confirm that the vocabulary talk moves identified in the present study promote students' oral language and vocabulary development. While some observational studies have found correlations between vocabulary instructional methods and students' learning (e.g., Carlisle et al., 2013; Neugebauer et al., 2017; Silverman & Crandell, 2010), the relationship between the vocabulary talk moves identified in the present study and students' oral language and vocabulary development have not yet been examined. Although the vocabulary talk moves identified in the

present study are aligned with research suggesting they would promote oral language and vocabulary development, future research is needed to determine if this is the case.

Future Research

Further research is needed to examine how teachers' use of vocabulary talk moves during science instruction impacts students' oral language and vocabulary development. All of the vocabulary talk moves identified in the present study align with research and theory on how children learn words, suggesting that these vocabulary talk moves should promote students' oral language and vocabulary development. An observational study of vocabulary talk during science instruction is needed now to confirm this hypothesis. Using the codebook for vocabulary talk developed in the present study and measures of students' vocabulary knowledge (e.g., knowledge of target words taught within science lessons, general vocabulary knowledge), statistical analysis should be used to determine the correlation between each type of vocabulary talk and students' word learning. Further statistical analysis could also determine the correlation between each vocabulary talk move and students' word learning. Once the relationship between teachers' vocabulary talk and students' oral language and vocabulary development has been established, follow-up studies of professional development could aim to increase teachers' use of *Student Word Use, Metalinguistic & Metacognitive Awareness,* and *Affective Factors* talk—given that these types of vocabulary talk are correlated with oral language and vocabulary development.

The present study focused on teachers' vocabulary talk within science instruction in early elementary classrooms, as little is known about how teachers promote oral language and vocabulary development during early-elementary science lessons; however, the vocabulary talk moves identified in this study could be examined across the school day. Future research should

also explore vocabulary talk beyond science instruction in order to learn how teachers promote oral language and vocabulary development in other content areas (e.g., social studies, mathematics), as additional vocabulary talk moves that were not identified in the present study may be commonly used in these areas.

The present study examined one science lesson from three different sets of science curriculum materials and identified three different curricular features associated with enhanced vocabulary talk when present and considerably less vocabulary talk when absent. A content analysis of a wide range of science curriculum materials could build on this work by identifying how prevalent these features are in the curriculum options available to teachers. This type of analysis could provide valuable information for curriculum developers and curriculum adopters. Relatedly, future research should aim to identify additional features of science curriculum materials associated with enhanced vocabulary talk by examining vocabulary talk in relation to a wider range of science curriculum materials with a greater number of teachers.

Conclusions

This study contributes to the field's understanding of the ways that science instruction supports literacy learning and literacy instruction supports science learning in the early-elementary grades. This is particularly important because science instruction offers a rich context for oral language and vocabulary development (Gotwals & Wright, 2017; Wright & Gotwals, 2017; Wright & Neuman, 2014), yet little time is devoted to science instruction in elementary classrooms (Berliner, 2011; Blank, 2012) and little is known about how teachers promote oral language and vocabulary development during science instruction. This study shows that teachers primarily engage in *Knowledge & Understanding* vocabulary talk during science lessons in the early-elementary grades, and vocabulary talk is enhanced when teachers use science curriculum

materials that target conceptually-connected vocabulary words for instruction and highlight these words through careful text selection and related discussion prompts.

APPENDICES

APPENDIX A—SOLID START PD RECRUITMENT INFORMATION

***S**cience, **O**ral Language and **Li**teracy **D**evelopment from the **Start** of School*
(**SOLID Start**) Professional Development and Research Partnership Opportunity

You're invited!

Who: K-2 teachers
What: Become a research partner for the online SOLID Start Professional Development course
When: Spring 2019 (beginning in early February)
Where: Wherever you are (online course)
Why: Learn about important practices for science and literacy learning *and* support the development of the SOLID Start Professional Development course!
How: Contact Dr. Tanya Wright (tswright@msu.edu) or Dr. Amelia Wenk Gotwals (gotwals@msu.edu) with questions or to sign up; enrollment is on first come, first served basis.

What is SOLID Start?

- SOLID Start, which stands for ***S**cience, **O**ral Language and **Li**teracy **D**evelopment from the **Start** of School*, is a project designed to support K-2 teachers in integrating science, oral language, and literacy in their teaching.
- SOLID Start is developing NGSS-aligned curriculum, a formative classroom observation tool to support teachers in enacting high-quality discourse, and online professional development and coaching.
- SOLID Start is funded by the National Science Foundation and led by Dr. Tanya Wright and Dr. Amelia Wenk Gotwals of Michigan State University's Department of Teacher Education.

What will SOLID Start research partners do?

- Participate in a 10-week online professional development focused on supporting talk around equitable science participation and engagement, deepening students' science understanding, and supporting students' science language and literacy development.
- Upload three videos of teaching science lessons throughout the course and receive feedback from a coach on these lessons
- Provide feedback on the course through surveys, interviews, and/or focus groups.

What are the objectives of the SOLID Start professional development?

Teachers will learn about why the three following practices are important for science and literacy learning:

1) Fostering equitable science participation and engagement
2) Deepening students' science understanding, and
3) Supporting students' science language and literacy development.

Teachers will gain strategies for implementing these practices, through analysis of videos, reading articles, and enacting and reflecting upon their own instruction.

What are the benefits of becoming a SOLID Start research partner?

- Learn about fostering equitable science participation and engagement, deepening students' science understanding, and supporting students' science language and literacy development.
- Receive support from a coach who will support you in reflecting on your teaching practices related to language and literacy development in the context of science learning.
- Receive a $500 stipend and SCECHs (number TBD).

APPENDIX B—DEMOGRAPHIC BACKGROUND AND TEACHING EXPERIENCE

INFORMATION SURVEY

Name:
Date:

Part 1: Background

1. What is your gender?
    - Female
    - Male
    - Gender Diverse

2. What are your pronouns?
    - She/her
    - He/him
    - They/their

3. In what year were you born?

4. Check ALL the categories that best describe your race or ethnicity:
    - Black or African American
    - Arab American
    - Hispanic or Latino/a
    - White or European American
    - Asian/Pacific Islander
    - Native American
    - Multiracial
    - Other:

5. Is English your first language?
    - Yes
    - No

6. If no, what is your first language?

Part 2: Professional Experience

1. For each degree you hold, please provide the following information:
    a. Education degree
        - Associate's degree
        - Bachelor's degree (BA or BS)
        - Master's degree
        - Doctoral degree
    b. Major, minor, and/or focus area (e.g., elementary education):
    c. Year of graduation:

2. Which teaching certification do you currently have? (Check one.)
    a. Provisional certificate (initial teaching license)
    b. Professional education certificate (advanced teaching license)
    c. Temporary teacher employment authorization (one year non-renewable)
    d. Other:

3. Which endorsements do you have? (Check all that apply.)
    - Special Education Consultant
    - English as a Second Language
    - Early Childhood Education
    - National Board Certification
    - Reading
    - Reading Specialist
    - Special Education
    - None
    - Other:

4. How many years have you worked as a teacher? (Check one.)
    - Fewer than 5
    - 6-10
    - 11-15
    - 16-20
    - Over 20

5. How many years have you taught the grade level you're currently teaching? (Check one.)
    - Fewer than 5
    - 6-10
    - 11-15
    - 16-20
    - Over 20

6. How long have you worked at your current location?

Part 3: Professional Development

1. In the past year, in which content areas did you attend or receive professional development? (Check all that apply.)
    - Language arts: Reading
    - Language arts: Writing
    - Math
    - Science
    - Social Studies
    - Other:

2. Please specify the topics the PD covered for each content area you indicated above.

Part 4: Setting Description

1. How many children in your class belong to each of the following groups?
    a. Black or African American:
    b. Middle Eastern/Arab:
    c. Hispanic or Latino/a:
    d. Asian or Pacific Islander:
    e. White or European American:
    f. Biracial or multiethnic:
    g. Other race or ethnicity:

2. How many children in your class have a documented special need or learning disability?

3. How many children in your class are English learners (learning English as an additional language)?

Part 5: Science and Literacy Curriculum

1. For each subject area, please list the name(s) of the curricula you use (i.e. Open Court; Reading Street). If you use more than one curriculum per subject area, please list them all. Also, add supplementary materials or your own materials, if you use them.
    a. Language Arts: Reading:
    b. Language Arts: Writing:
    c. Language Arts: Oral Language/vocabulary:
    d. Science:

2. How closely do you follow the language arts curricula you use?
    a. I follow it strictly.
    b. I follow it most of the time/make adaptations when appropriate.
    c. I use it occasionally/select pieces that are appropriate for my students.
    d. I rarely use it.

3. How closely do you follow the science curricula you use?
    a. How closely do you follow the science curricula you use?
    a. I follow it strictly.
    b. I follow it most of the time/make adaptations when appropriate.
    c. I use it occasionally/select pieces that are appropriate for my students.
    d. I rarely use it.

4. Who selects the language arts curricula that you use in your classroom? (Check one.)
    - ☐ My school district
    - ☐ My principal
    - ☐ I do
    - ☐ Other:

5. Who selects the science curricula that you use in your classroom? (Check one.)
    - ☐ My school district

- My principal
- I do
- Other:

APPENDIX C—WEEKLY INSTRUCTIONAL LOG

Name:
Week of PD: [Before PD, Week 1, Week 2, … Week 10]

1. How many times did you teach science this week?
2. How many minutes did you teach science each time (e.g., Monday: 30 minutes, Tuesday: 40 minutes, Thursday: 20 minutes)?
3. Comments (e.g., two snow days this week, no school for holiday on Monday, field trip on Thursday)
4. What did content did you teach in this week's science lessons?
5. Did you use curriculum materials? [yes no]
6. If you responded yes, what curriculum materials did you use?

APPENDIX D—TRANSCRIPTION GUIDE

General Instructions

- Every line must end with a carriage return.
- Each utterance gets its own line (i.e., only one utterance per line).
- Use T and teacher number to identify the teacher as speaker. For example, TEA40 is noted in transcripts as T40.
- Use CHI (for *child*) for all student talk (whether one student is speaking or multiple students are speaking).

Utterances

This study uses the utterance as the unit of analysis. For this study an utterance is defined as a unit of speech bounded by only one speaker (i.e., bound by conversational turns) and one main clause (subject-predicate) (MacWhinney, 2000; Neugebauer et al., 2017; Rex & Schiller, 2009).

As a *conversational unit* (c-unit), an utterance has only one main clause (subject-predicate) but may have a dependent clause as well (MacWhinney, 2000). The sentence *I'm going home, which is far away* is one utterance.

If two clauses are joined by one of these coordinating conjunctions, use a separate tier for the coordinating conjunction and clause that follows: and, but, for, nor, or, yet, so. For example, if two independent clauses are joined by *and*, each independent clause is a separate utterance. For the compound sentence *This is my bike, and it goes fast*, there are two utterances:

this is my bike.
and it goes fast.

Transcription Notes Regarding Utterances:

- Each utterance gets its own line.
- Start each utterance with the three-character participant code, a colon, and a space. For example, a student utterance looks like this:
  CHI: I had to push it to make it go.
- Do not capitalize the first word unless it is a proper noun.
- End each utterance with a period, question mark, or exclamation point.
  - Period: use with declarative utterance
    - this is an utterance. [utterance spoken without emphasis or rising contour]
  - Question mark: use when a question is asked (in any of the following forms):
    - what is an utterance? [utterance has question word]
    - is that an utterance? [utterance has inverted subject-verb]
    - that's an utterance, right? [utterance has tag question ending]
    - utterance? [utterance is spoken with final rising contour]
  - Exclamation point: use with imperative or emphatic utterance
    - this is an utterance! [utterance spoken with emphasis]
- If the speaker doesn't finish what they were saying,
  - use ... to indicate that the speaker trailed off. This is typically used when the speaker is prompting students to fill in the "blank" they're creating by trailing off.

    - use / to indicate that another speaker interrupted
    - use // to indicate that that speaker interrupted themselves (i.e., incomplete thought that didn't just trail off, false start)
- If there's a pause that interrupts the flow of speech, mark it with the number of seconds it lasts in parentheses. For example, a 2-second pause in the utterance *I noticed there were cumulonimbus clouds* would be transcribed as

  CHI: I noticed there were (2) cumulonimbus clouds.
- If multiple speakers speak at the same time,
    - use angle brackets (< >) when speakers speak at the same time. Place what is being said at the same time inside the brackets for each speaker.

      T11: the types of force we're talking about today are <pushes and pulls>.

      CHI: <gravity is a force>.
- When a speaker quotes someone or something:
    - use beginning (“)and ending quotation (”) marks around the quoted words.

      T11: the meteorologist said today's weather would be “sweltering”.
    - If the speaker reads text aloud, use { and } around what is being read

      T11: {the wild things roared their terrible roars}.
- Use xxx to indicate unintelligible speech when you cannot hear or understand what the speaker is saying.
- If you're pretty sure you know what was said but aren't positive, use comment to note that it is a best guess.
- When a word is incomplete but the intended meaning seems clear, insert the missing material within parentheses. (Do not insert fully omitted words.)

  (be)cause

  (un)til

  (a)bout

  (o)kay
- Use www to indicate that some utterances are being left out (e.g., teacher answers phone or talks to another teacher); comment in the next tier (dependent tier) to explain why utterances were left out
- Use Name in place of student's names if speaker calls student by name.
- If the speaker makes a sound effect, either make a comment to describe the sound effect (e.g., *teacher made the sound of a train whistle*). If unsure of what the sound is, spell the sound as best you can and put that in the transcript itself between slashes (e.g., /sloosheywoo/).

Providing Additional Information

To note any kind of additional information that is needed to understand what's going on in the video, make a comment in the row immediately following the utterance to which it refers. Type the comment in italics so that it easily stands out as not being an utterance.

teacher waves arm like flag on a windy day

teacher is typing the words as she says them

student is pointing to the flag

students are acting out shivering

Questions/Decisions

- Student repetitions/false starts: separate by commas but okay to keep all on same main line since teacher talk is the focus.
- Teacher false starts: if teacher has several false starts in a row, put them all on the same main line→ then put the full utterance that follows on a new line.
    - T11: I, uh, we went, it wasn't //
    - T11: that was the first time we went.
- If teacher repeats a word/phrase in the middle of an utterance (not just a false start) and then continues the utterance, keep those repetitions on the same line.
- Pay attention to intonation curves. If it sounds like the speaker has said their complete thought but then tacks something at the end after final intonation (rising for question or falling for statement), put what's tacked on on a new line (new utterance).

APPENDIX E—VOCABULARY TALK CODEBOOK

Knowledge & Understanding Vocabulary Talk Moves

Vocabulary Talk Move	Description	Example
Introduce Word	Teacher draws attention to a new word	And this big word is *arrangement*.
Review Word	Teacher reminds students of a word that's already been introduced	Do you remember what a *habitat* is?
Explain/Define	Teacher explicitly provides an explanation or definition of a word	So *bipeds* are animals that use two legs for walking.
Use with Hint	Teacher uses word in context but provides some kind of hint/context clue	So, you will have to design some sort of *crossing* for your animal to get across the road or for, or under the road.
Act Out/Demonstrate	Teacher acts out a word's meaning	Instead of the wind moving every which way, it spins in a circle. [Teacher demonstrates *tornado* movement with fingers.]
Elicit Student Ideas: Act Out	Teacher asks students to act out a word's meaning	Show me what that would look like.
Example/Nonexample	Teacher shares an example or nonexample of a word	Grass can also be *shelter* for animals.
Elicit Student Ideas: Example/Nonexample	Teacher asks students to share an example or nonexample of a word	Do you have another *extreme* weather, Micah?
Elicit Student Ideas: New Word	Teacher asks students what a new word means	What does *prepare* mean?
Elicit Student Ideas: Review Word	Teacher asks students what a review word means	What do we know about *stratus* clouds?
Elicit Student Ideas: Synonym	Teacher asks students for a synonym	What's another name for *concrete*?
Provide Visual Support	Teacher shows an image of what a word means	We get this gap in between and we still have landforms that are really high on either side. [Teacher is pointing to image of a *canyon*.]
Differentiate Meaning	Teacher explains what word means in a particular context vs. another	Not like outer space but like we need *space* to move.
Use Target Word	Teacher says target word	Yes, the *wind* in our classroom is *calm*.

Emphasize	Teacher emphasizes target word and/or its meaning	So is it a *mammal*?
Visually Display Word	Teacher shows students a word	This word says *severe*.
Elicit Student Questions: Target Word	Teacher asks students what they want to know about a target word	What did we want to know about *sound*?
Highlight Words Across Domains	Teacher draws students' attention to word from another domain	What a great math word! [diagonal]
Offer Alternative	Teacher offers an alternative way to say something	Instead of saying so, so, so, so, so, we could say it was *extreme*.
Comment on Spelling	Teacher draws attention to the spelling of a word	*Friction* has a blend at the beginning.
Restate Differently	Teacher restates something to make it more comprehensible	Scientists think birds are related to dinosaurs. [Text: Birds are living dinosaurs.]

Affective Factors Vocabulary Talk Moves

Vocabulary Talk Move	Description	Example
Help Students Make Personal Connection	Teacher connects word to students' personal experiences	In the past three, four days, we've had some *severe* weather conditions.
Praise	Teacher praises student word use	That's a good weather word!
Acknowledge Student Ownership	Teacher acknowledges students' ownership of words	Myra said there's a *force* happening here.
Answer a Question	Teacher answers students' questions about what words mean	The smallest [wind] would be *calm*.
Appreciate Word/Word Choice	Teacher comments on word choice	Here's another good word.
Highlight Favorite Words	Teacher talks about favorite/liked words	That is one of my favorite words. [precipitation]

Student Word Use Vocabulary Talk Moves

Vocabulary Talk Move	Description	Example
Ask to Repeat	Teacher asks students to repeat after her	Try that word.
Prompt Word	Teacher prompts word or meaning	So if it ate plants, what was it called? [herbivore]
Elicit New Word from Students	Teacher asks students for a word that hasn't been introduced/discussed	Does anyone know the science word when you kind of blend into your environment?
Encourage to Use Later	Teacher encourages students to use words later	So you will be using this word later?
Suggest Word/Phrase	Teacher suggests another way to say something	Maybe we could say the word *breezy*.
Revoice	Teacher elevates students' word use	S: Yeah, they're going in a circle. T: They are moving in a *curve*.

Metacognitive and Metalinguistic Awareness Vocabulary Talk Moves

Vocabulary Talk Move	Description	Example
Ask if Heard of Word	Teacher asks students if familiar with word.	Thumbs up if you've ever heard of that word before.

REFERENCES

REFERENCES

Anderson, R. C., & Freebody, P. (1981). Vocabulary knowledge. In J. T. Guthrie (Ed.), *Comprehension and teaching: Research reviews* (pp. 77–117). International Reading Association.

Anderson, R. C., & Nagy, W. E. (1991). Word meanings. In R. Barr, Kamil, Michael L., P. B. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research* (2nd ed., pp. 690–724). Lawrence Erlbaum Associates.

Anderson, R. C., & Nagy, W. E. (1992). The vocabulary conundrum. *American Educator: The Professional Journal of the American Federation of Teachers*, *16*(4). http://eric.ed.gov/?id=EJ458646

Barnes, E. M., & Dickinson, D. K. (2017a). The impact of teachers' commenting strategies on children's vocabulary growth. *Exceptionality*, *25*(3), 186–206. https://doi.org/10.1080/09362835.2016.1196447

Barnes, E. M., & Dickinson, D. K. (2017b). The relationship of Head Start teachers' academic language use and children's receptive vocabulary. *Early Education and Development*, *28*(7), 794–809. https://doi.org/10.1080/10409289.2017.1340069

Barnes, E. M., & Dickinson, D. K. (2018). Relationships among teachers' use of mental state verbs and children's vocabulary growth. *Early Education and Development*, *29*(3), 307–323. https://doi.org/10.1080/10409289.2018.1440844

Barnes, E. M., Dickinson, D. K., & Grifenhagen, J. F. (2017). The role of teachers' comments during book reading in children's vocabulary growth. *The Journal of Educational Research*, *110*(5), 515–527. https://doi.org/10.1080/00220671.2015.1134422

Barone, D. M. (2011). Case study research. In *Literacy research methodologies* (2nd ed., pp. 7–27). Guilford Press.

Baumann, J. F., Edwards, E. C., Boland, E. M., Olejnik, S., & Kame'enui, E. J. (2003). Vocabulary tricks: Effects of instruction in morphology and context on fifth-grade students' ability to derive and infer word meanings. *American Educational Research Journal*, *40*(2), 447–494.

Baumann, J. F., Edwards, E. C., Font, G., Tereshinski, C. A., Kame'enui, E. J., & Olejnik, S. (2002). Teaching morphemic and contextual analysis to fifth-grade students. *Reading Research Quarterly*, *37*(2), 150–176. https://doi.org/10.1598/RRQ.37.2.3

Baumann, J. F., Ware, D., & Edwards, E. C. (2007). “Bumping into spicy, tasty words that catch your tongue”: A formative experiment on vocabulary instruction. *The Reading Teacher*, *61*(2), 108–122.

Beck, I. L., & McKeown, M. G. (2001). Text talk: Capturing the benefits of read-aloud experiences for young children. *The Reading Teacher*, *55*(1), 10–20.

Beck, I. L., & McKeown, M. G. (2004). *Elements of reading vocabulary: Teacher’s guide level A (Harcourt Supplemental Publishers, Rigby Steck-Vaughn, Item Number 0-7398-8458-1)*. Steck-Vaughn.

Beck, I. L., & McKeown, M. G. (2007). Increasing young low-income children’s oral vocabulary repertoires through rich and focused instruction. *The Elementary School Journal*, *107*(3), 251–271. https://doi.org/10.1086/511706

Beck, I. L., McKeown, M. G., & McCaslin, E. S. (1983). Vocabulary development: All contexts are not created equal. *The Elementary School Journal*, 177–181.

Beck, I. L., McKeown, M. G., & Omanson, R. (1987). The effects and uses of diverse vocabulary instructional techniques. In M. G. McKeown & M. E. Curtis (Eds.), *The nature of vocabulary acquisition* (pp. 147–163). Lawrence Erlbaum Associates.

Beck, I. L., McKeown, M. G., Sandora, C., Kucan, L., & Worthy, J. (1996). Questioning the author: A yearlong classroom implementation to engage students with text. *The Elementary School Journal*, *96*(4), 385–414. https://doi.org/10.1086/461835

Berliner, D. (2011). Rational responses to high stakes testing: The case of curriculum narrowing and the harm that follows. *Cambridge Journal of Education*, *41*(3), 287–302. https://doi.org/10.1080/0305764X.2011.607151

Biemiller, A., & Boote, C. (2006). An effective method for building meaning vocabulary in primary grades. *Journal of Educational Psychology*, *98*(1), 44–62. https://doi.org/10.1037/0022-0663.98.1.44

Blachowicz, C. L. Z. (1987). Vocabulary instruction: What goes on in the classroom? *The Reading Teacher*, *41*(2), 132–137.

Blachowicz, C. L. Z., Baumann, J. F., Manyak, P. C., & Graves, M. F. (2013). *“FLOOD, FAST, FOCUSED”: Integrated vocabulary instruction in the classroom*. International Reading Association.

Blank, R. K. (2012). *What is the impact of decline in science instructional time in elementary school?* Noyce Foundation.

Bohannon, J. N., & Bonvillian, J. D. (2001). Theoretical approaches to language acquisition. In J. B. Gleason (Ed.), *The development of language* (5th ed., pp. 254–314). Allyn and Bacon.

Boulware-Gooden, R., Carreker, S., Thornhill, A., & Joshi, R. M. (2007). Instruction of metacognitive strategies enhances reading comprehension and vocabulary achievement of third-grade students. *The Reading Teacher*, *61*(1), 70–77. https://doi.org/10.1598/RT.61.1.7

Bowers, E. P., & Vasilyeva, M. (2011). The relation between teacher input and lexical growth of preschoolers. *Applied Psycholinguistics*, *32*(1), 221–241. https://doi.org/10.1017/S0142716410000354

Bowers, P. N., & Kirby, J. R. (2010). Effects of morphological instruction on vocabulary acquisition. *Reading and Writing*, *23*(5), 515–537. https://doi.org/10.1007/s11145-009-9172-z

Bravo, M. A., & Cervetti, G. N. (2008). Teaching vocabulary through text and experience in content areas.pdf. In A. E. Farstrup & S. J. Samuels (Eds.), *What research has to say about vocabulary instruction* (pp. 130–149). International Reading Association.

Bruner, J. (1978). The role of dialogue in language acquisition. In A. Sinclair, R. Jarvella, & W. Levelt (Eds.), *The child's conception of language*. Springer-Verlag.

Cain, K. (2007). Deriving word meanings from context: Does explanation facilitate contextual analysis? *Journal of Research in Reading*, *30*(4), 347–359. https://doi.org/10.1111/j.1467-9817.2007.00336.x

Carlisle, J. F., Kelcey, B., & Berebitsky, D. (2013). Teachers' support of students' vocabulary learning during literacy instruction in high poverty elementary schools. *American Educational Research Journal*, *50*(6), 1360–1391. https://doi.org/10.3102/0002831213492844

Carlo, M. S., August, D., McLaughlin, B., Snow, C. E., Lippman, D. N., Lively, T. J., & White, C. E. (2004). Closing the gap: Addressing the vocabulary needs of English-language learners in bilingual and mainstream classrooms.pdf. *Reading Research Quarterly*, *39*(2), 188–215.

Cervetti, G. N., Barber, J., Dorph, R., Pearson, P. D., & Goldschmidt, P. G. (2012). The impact of an integrated approach to science and literacy in elementary school classrooms. *Journal of Research in Science Teaching*, *49*(5), 631–658. https://doi.org/10.1002/tea.21015

Cervetti, G. N., Wright, T. S., & Hwang, H. (2016). Conceptual coherence, comprehension, and vocabulary acquisition: A knowledge effect? *Reading and Writing*, *29*(4), 761–779. https://doi.org/10.1007/s11145-016-9628-x

Chambré, S. J., Ehri, L. C., & Ness, M. (2017). Orthographic facilitation of first graders' vocabulary learning: Does directing attention to print enhance the effect? *Reading and Writing*, *30*(5), 1137–1156. https://doi.org/10.1007/s11145-016-9715-z

Chambrè, S. J., Ehri, L. C., & Ness, M. (2019). Phonological decoding enhances orthographic facilitation of vocabulary learning in first graders. *Reading and Writing*. https://doi.org/10.1007/s11145-019-09997-w

Connor, C. M., Dombek, J., Crowe, E. C., Spencer, M., Tighe, E. L., Coffinger, S., Zargar, E., Wood, T., & Petscher, Y. (2017). Acquiring science and social studies knowledge in kindergarten through fourth grade: Conceptualization, design, implementation, and efficacy testing of content-area literacy instruction (CALI). *Journal of Educational Psychology, 109*(3), 301–320. https://doi.org/10.1037/edu0000128

Cox, R., O'Brien, K., Walsh, M., & West, H. (2015). Working with multilingual learners and vocabulary knowledge for secondary schools: Developing word consciousness. *English in Australia*, *50*(1), 77–84.

Coyne, M. D., McCoach, D. B., & Kapp, S. (2007). Vocabulary intervention for kindergarten students: Comparing extended instruction to embedded instruction and incidental exposure. *Learning Disability Quarterly*, *30*(2), 74–88.

Coyne, M. D., McCoach, D. B., Loftus, S., Zipoli, R., Ruby, M., Crevecoeur, Y. C., & Kapp, S. (2010). Direct and extended vocabulary instruction in kindergarten: Investigating transfer effects. *Journal of Research on Educational Effectiveness*, *3*(2), 93–120. https://doi.org/10.1080/19345741003592410

Coyne, M. D., McCoach, D. B., Loftus, S., Zipoli Jr., R., & Kapp, S. (2009). Direct vocabulary instruction in kindergarten: Teaching for breadth versus depth. *The Elementary School Journal*, *110*(1), 1–18. https://doi.org/10.1086/598840

Dale, E. (1965). Vocabulary measurement: Techniques and major findings. *Elementary English*, 895–948.

Davis, F. B. (1944). Fundamental factors of comprehension in reading. *Psychometrika*, *9*(3), 185–197.

Dickinson, D. K., Cote, L., & Smith, M. W. (1993). Learning vocabulary in preschool: Social and discourse contexts affecting vocabulary growth. *New Directions for Child and Adolescent Development*, *1993*(61), 67–78. https://doi.org/10.1002/cd.23219936106

Dickinson, D. K., Darrow, C. L., & Tinubu, T. A. (2008). Patterns of teacher–child conversations in Head Start classrooms: Implications for an empirically grounded approach to professional development. *Early Education & Development*, *19*(3), 396–429. https://doi.org/10.1080/10409280802065403

Dickinson, D. K., & Porche, M. V. (2011). Relation between language experiences in preschool classrooms and children's kindergarten and fourth-grade language and reading abilities: Preschool language experiences and later language and reading. *Child Development, 82*(3), 870–886. https://doi.org/10.1111/j.1467-8624.2011.01576.x

Dickinson, D. K., & Smith, M. W. (1994). Long-term effects of preschool teachers' book readings on low-income children's vocabulary and story comprehension. *Reading Research Quarterly*, *29*(2), 104. https://doi.org/10.2307/747807

Dickinson, D. K., & Tabors, P. O. (1991). Early literacy: Linkages between home, school and literacy achievement at age five. *Journal of Research in Childhood Education*, *6*(1), 30–46. https://doi.org/10.1080/02568549109594820

Ehri, L. C. (2014). Orthographic mapping in the acquisition of sight word reading, spelling memory, and vocabulary learning. *Scientific Studies of Reading*, *18*(1), 5–21. https://doi.org/10.1080/10888438.2013.819356

Ehri, L. C., & Rosenthal, J. (2007). Spellings of words: A neglected facilitator of vocabulary learning. *Journal of Literacy Research*, *39*(4), 389–409.

Freeman, N. D., Townsend, D., & Templeton, S. (2019). Thinking about words: First graders' response to morphological instruction. *The Reading Teacher*, *72*(4), 463–473. https://doi.org/10.1002/trtr.1749

Fukkink, R. G., & de Glopper, K. (1998). Effects of instruction in deriving word meaning from context: A meta-analysis. *Review of Educational Research, 68*, 450–469.

Gee, J. P. (2014). *How to do discourse analysis: A toolkit* (2nd ed.). Routledge.

Gotwals, A. W., & Wright, T. S. (2017). From "plants don't eat" to "plants are producers." *Science and Children*, *55*(3), 44–50.

Graves, M. F. (2000). A vocabulary program to complement and bolster a middle-grade comprehension program. In B. M. Taylor, M. F. Graves, & P. van den Broek (Eds.), *Reading for meaning* (pp. 116–135). International Reading Association.

Graves, M. F. (2006). *The vocabulary book: Learning and instruction*. Teachers College Press.

Graves, M. F., & Watts-Taffe, S. (2002). The place of word consciousness in a research-based vocabulary program. In S. J. Samuels & A. E. Farstrup (Eds.), *What research has to say about reading instruction* (3rd ed., pp. 140–165). International Reading Association.

Graves, M. F., & Watts-Taffe, S. (2008). For the love of words: Fostering word consciousness in young readers. *The Reading Teacher*, *62*(3), 185–193. https://doi.org/10.1598/RT.62.3.1

Guthrie, J. T., Anderson, E., Alao, S., & Rinehart, J. (1999). Influences of Concept-Oriented Reading Instruction on strategy use and conceptual learning from text. *The Elementary School Journal, 99*(4), 343–366.

Guthrie, J. T., McRae, A., Coddington, C. S., Lutz Klauda, S., Wigfield, A., & Barbosa, P. (2009). Impacts of comprehensive reading instruction on diverse outcomes of low- and high-achieving readers. *Journal of Learning Disabilities*, *42*(3), 195–214. https://doi.org/10.1177/0022219408331039

Hadley, E. B., Dickinson, D. K., Hirsh-Pasek, K., & Golinkoff, R. M. (2019). Building semantic networks: The impact of a vocabulary intervention on preschoolers' depth of word knowledge. *Reading Research Quarterly*, *54*(1), 41–61. https://doi.org/10.1002/rrq.225

Hart, B., & Risley, T. R. (2003). The early catastrophe: The 30 million word gap by age 3. *American Educator, 27*(1), 4.

Jenkins, J. R., Matlock, B., & Slocum, T. A. (1989). Two approaches to vocabulary instruction: The teaching of individual word meanings and practice in deriving word meaning from context. *Reading Research Quarterly*, *24*(2), 215–235. https://doi.org/10.2307/747865

Johnson, R. (2013). *What is precipitation?* Crabtree Publishing Company.

Jubenville, K., Sénéchal, M., & Malette, M. (2014). The moderating effect of orthographic consistency on oral vocabulary learning in monolingual and bilingual children. *Journal of Experimental Child Psychology*, *126*, 245–263. https://doi.org/10.1016/j.jecp.2014.05.002

Juel, C., & Deffes, R. (2004). Making words stick. *Educational Leadership*, *61*(6), 30–34.

Kintsch, W. (2013). Revisiting the construction-integration model of text comprehension and its implications for instruction. In D. E. Alvermanm, N. J. Unrau, & R. B. Ruddell, *Theoretical models and processes of reading* (6th ed., pp. 807–839). International Reading Association.

Kuhn, D. (2000). Metacognitive development. *Current Directions in Psychological Science*, *9*(5), 4.

Lesaux, N. K., & Kieffer, M. J. (2010). Exploring sources of reading comprehension difficulties among language minority learners and their classmates in early adolescence. *American Educational Research Journal*, *47*(3), 596–632. https://doi.org/10.3102/0002831209355469

Lesaux, N. K., Kieffer, M. J., Faller, S. E., & Kelley, J. G. (2010). The effectiveness and ease of implementation of an academic vocabulary intervention for linguistically diverse students in urban middle schools. *Reading Research Quarterly*, *45*(2), 196–228. https://doi.org/10.1598/RRQ.45.2.3

Lubliner, S., & Smetana, L. (2005). The effects of comprehensive vocabulary instruction on Title I students' metacognitive word-learning skills and reading comprehension. *Journal of Literacy Research*, *37*(2), 163–200. https://doi.org/10.1207/s15548430jlr3702_3

MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk* (3rd ed.). Lawrence Erlbaum Associates.

Manyak, P. C., Von Gunten, H., Autenrieth, D., Gillis, C., Mastre-O'Farrell, J., Irvine-McDermott, E., Baumann, J. F., & Blachowicz, C. L. Z. (2014). Four practical principles for enhancing vocabulary instruction. *The Reading Teacher*, *68*(1), 13–23. https://doi.org/10.1002/trtr.1299

McKeown, M. G. (1985). The acquisition of word meaning from context by children of high and low ability. *Reading Research Quarterly*, *20*(4), 482–496. https://doi.org/10.2307/747855

McKeown, M. G. (1993). Creating effective definitions for young word learners. *Reading Research Quarterly*, *28*(1), 16. https://doi.org/10.2307/747814

McKeown, M. G., & Beck, I. L. (2003). Taking advantage of read-alouds to help children make sense of decontextualized language. In A. Van Kleeck, S. A. Stahl, & E. B. Bauer (Eds.), *On reading books to children* (pp. 159–176). Erlbaum.

McKeown, M. G., & Beck, I. L. (2004). Transforming knowledge into professional development resources: Six teachers implement a model of teaching for understanding text. *The Elementary School Journal*, *104*(5), 391–408. https://doi.org/10.1086/499759

McKeown, M. G., Beck, I. L., Omanson, R. C., & Perfetti, C. A. (1983). The effects of long-term vocabulary instruction on reading comprehension: A replication. *Journal of Reading Behavior*, *15*(1), 3–18. https://doi.org/10.1080/10862968309547474

McKeown, M. G., Beck, I. L., Omanson, R. C., & Pople, M. T. (1985). Some effects of the nature and frequency of vocabulary instruction on the knowledge and use of words. *Reading Research Quarterly*, *20*(5), 522. https://doi.org/10.2307/747940

Mercer, N., Dawes, L., Wegerif, R., & Sams, C. (2004). Reasoning as a scientist: Ways of helping children to use language to learn science. *British Educational Research Journal*, *30*(3), 359–377. https://doi.org/10.1080/0141192041000168968 9

Michaels, S., & O'Connor, C. (2012). *Talk science primer*. TERC.

Michaels, S., & O'Connor, C. (2015). Conceptualizing talk moves as tools: Professional development approaches for academically productive discussions. In L. B. Resnick, C. S. C. Asterhan, & S. N. Clarke (Eds.), *Socializing Intelligence Through Academic Talk and Dialogue* (pp. 347–361). American Educational Research Association. https://doi.org/10.3102/978-0-935302-43-1_27

Michener, C. J., Patrick Proctor, C., & Silverman, R. D. (2018). Features of instructional talk predictive of reading comprehension. *Reading and Writing*, *31*(3), 725–756. https://doi.org/10.1007/s11145-017-9807-4

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Sage.

Nagy, W. E. (2005). Why vocabulary instruction needs to be long-term and comprehensive. In E. Hiebert & M. L. Kamil (Eds.), *Teaching and learning vocabulary: Bringing research to practice* (pp. 27–44). Lawrence Erlbaum Associates.

Nagy, W. E., & Anderson, R. C. (1984). How many words are there in printed school English? *Reading Research Quarterly*, *19*(3), 304. https://doi.org/10.2307/747823

Nagy, W. E., & Herman, P. A. (1985). Incidental vs. Instructional approaches to increasing reading vocabulary. *Educational Perspectives*, 16–21.

Nagy, W. E., Herman, P. A., Anderson, R. C., & Pearson, P. D. (1984). *Learning words from context* (No. 319). University of Illinois at Urbana-Champaign. http://eric.ed.gov/?id=ED246392

Nagy, W. E., Herman, P. A., & Anderson, Richard C. (1985). *Learning word meanings from context: How broadly generalizable?* (No. 347). University of Illinois at Urbana-Champaign.

Nagy, W. E., & Scott, J. A. (2000). Vocabulary processes. In M. L. Kamil, P. B. Mosenthal, P. D. Pearson, & R. Barr, *Handbook of Reading Research* (Vol. 3, pp. 269–284). Lawrence Erlbaum Association.

Nash, H., & Snowling, M. (2006). Teaching new words to children with poor existing vocabulary knowledge: A controlled evaluation of the definition and context methods. *International Journal of Language & Communication Disorders*, *41*(3), 335–354. https://doi.org/10.1080/13682820600602295

National Center for Education Statistics. (2020). *Back to school statistics*. Institute of Education Research; National Center for Education Statistics. https://nces.ed.gov/fastfacts/display.asp?id=372#PK12_enrollment

National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010). *Common Core State Standards*. National Governors Association Center for Best Practices, Council of Chief State School.

National Institute of Child Health and Human Development. (2000). *Report of the National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction* (NIH Publication No. 004769). U.S. Government Printing Office.

National Research Council. (2007). *Taking science to school: Learning and teaching science in Grades K-8*. National Academies Press.

Nelson, K. L., Dole, J. A., Hosp, J. L., & Hosp, M. K. (2015). Vocabulary instruction in K-3 low-income classrooms during a reading reform project. *Reading Psychology, 36*(2), 145–172. https://doi.org/10.1080/02702711.2013.839485

Neugebauer, S. R., Gámez, P. B., Coyne, M. D., Cólon, I. T., McCoach, D. B., & Ware, S. (2017). Promoting word consciousness to close the vocabulary gap in young word learners. *The Elementary School Journal*, *118*(1), 28–54. https://doi.org/10.1086/692986

Neuman, S. B., & Dwyer, J. (2011). Developing vocabulary and conceptual knowledge for low-income preschoolers: A design experiment. *Journal of Literacy Research*, *43*(2), 103–129. https://doi.org/10.1177/1086296X11403089

Neuman, S. B., & Kaefer, T. (2013). Enhancing the intensity of vocabulary instruction for preschoolers at risk. *The Elementary School Journal*, *113*(4), 589–608.

Neuman, S. B., & Kaefer, T. (2018). Developing low-income children's vocabulary and content knowledge through a shared book reading program. *Contemporary Educational Psychology, 52*, 15–24. https://doi.org/10.1016/j.cedpsych.2017.12.001

Neuman, S. B., Newman, E. H., & Dwyer, J. (2011). Educational effects of a vocabulary intervention on preschoolers' word knowledge and conceptual development: A cluster-randomized trial. *Reading Research Quarterly*, *46*(3), 249–272.

Neuman, S. B., & Wright, T. S. (2013). *All about words: Increasing vocabulary in the Common Core Classroom, prek-2*. Teachers College Press.

NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*.

Nystrand, M. (2006). Research on the role of classroom discourse as it affects reading comprehension. *Research in the Teaching of English*, *40*(4), 392–412.

O'Connor, C., & Michaels, S. (1993). Aligning academic task and participation status through revoicing: Analysis of a classroom discourse strategy. *Anthropology Education Quarterly, 24*(4), 318–335. https://doi.org/10.1525/aeq.1993.24.4.04x0063k

O'Connor, C., & Michaels, S. (1996). Shifting participant frameworks: Orchestrating thinking practices in group discussion. In D. Hicks (Ed.), *Discourse, learning, and schooling* (pp. 63–103). Cambridge University Press.

O'Connor, C., & Michaels, S. (2019). Supporting teachers in taking up productive talk moves: The long road to professional learning at scale. *International Journal of Educational Research, 97*, 166–175. https://doi.org/10.1016/j.ijer.2017.11.003

Ouellette, G., & Beers, A. (2010). A not-so-simple view of reading: How oral vocabulary and visual-word recognition complicate the story. *Reading and Writing*, *23*(2), 189–208. https://doi.org/10.1007/s11145-008-9159-1

Paris, S. G. (2005). Reinterpreting the development of reading skills. *Reading Research Quarterly*, *40*(2), 184–202. https://doi.org/10.1598/RRQ.40.2.3

Pollard-Durodola, S. D., Gonzalez, J. E., Simmons, D. C., Kwok, O., Taylor, A. B., Davis, M. J., Kim, M., & Simmons, L. (2011). The effects of an intensive shared book-reading intervention for preschool children at risk for vocabulary delay. *Exceptional Children*, *77*(2), 161–183. https://doi.org/10.1177/001440291107700202

Ratner, N. B., & Brundage, S. B. (2018). *A clinician's complete guide to CLAN and PRAAT*.

Rex, L. A., & Schiller, L. (2009). *Using discourse analysis to improve classroom interaction*. Routledge.

Richmond, G., & Striley, J. (1996). Making meaning in classrooms: Social processes in small-group discourse and scientific knowledge building. *Journal of Research in Science Teaching*, *33*(8), 839–858. https://doi.org/10.1002/(SICI)1098-2736(199610)33:8<839::AID-TEA2>3.0.CO;2-X

Ricketts, J., Bishop, D. V. M., & Nation, K. (2009). Orthographic facilitation in oral vocabulary acquisition. *Quarterly Journal of Experimental Psychology*, *62*(10), 1948–1966. https://doi.org/10.1080/17470210802696104

Ricketts, J., Nation, K., & Bishop, D. V. M. (2007). Vocabulary is important for some, but not all reading skills. *Scientific Studies of Reading*, *11*(3), 235–257. https://doi.org/10.1080/10888430701344306

Robbins, C., & Ehri, L. C. (1994). Reading storybooks to kindergartners helps them learn new vocabulary words. *Journal of Educational Psychology*, *86*(1), 54–64.

Romance, N. R., & Vitale, M. R. (1992). A curriculum strategy that expands time for in-depth elementary science instruction by using science-based reading strategies: Effects of a year-long study in grade four. *Journal of Research in Science Teaching*, *29*(6), 545–554. https://doi.org/10.1002/tea.3660290604

Romance, N. R., & Vitale, M. R. (2001). Implementing an in-depth expanded science model in elementary schools: Multi-year findings, research issues, and policy implications. *International Journal of Science Education*, *23*(4), 373–404.

Rosenthal, J., & Ehri, L. C. (2008). The mnemonic value of orthography for vocabulary learning. *Journal of Educational Psychology*, *100*(1), 175–191. https://doi.org/10.1037/0022-0663.100.1.175

Rosenthal, J., & Ehri, L. C. (2011). Pronouncing new words aloud during the silent reading of text enhances fifth graders' memory for vocabulary words and their spellings. *Reading and Writing*, *24*(8), 921–950. https://doi.org/10.1007/s11145-010-9239-x

Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). SAGE.

Schacht, K., & Peltz, D. (2020). *Mystery Science: Open-and-go lessons that inspire kids to love science*. Mystery Science. https://mysteryscience.com/lessons/seasonal/current-events

Scott, J. A., Jamieson-Noel, D., & Asselin, M. (2003). Vocabulary instruction throughout the day in twenty-three Canadian upper-elementary classrooms. *The Elementary School Journal*, 269–286.

Scott, J. A., & Nagy, W. E. (2004). Developing word consciousness. In E. J. Kame'enui & J. F. Baumann (Eds.), *Vocabulary instruction: Research to practice* (1st ed., pp. 201–217). Guilford Press.

Senechal, M., Ouellette, G., & Rodney, D. (2006). The misunderstood giant: On the predictive role of early vocabulary to future reading. In S. B. Neuman & D. K. Dickinson (Eds.), *Handbook of early literacy research* (2nd ed., pp. 173–182). Guilford Press.

Silverman, R. (2007a). Vocabulary development of English-language and English-only learners in kndergarten. *The Elementary School Journal*, *107*(4), 365–383. https://doi.org/10.1086/516669

Silverman, R. (2007b). A comparison of three methods of vocabulary instruction during read-alouds in kindergarten. *The Elementary School Journal*, *108*(2), 97–113. https://doi.org/10.1086/525549

Silverman, R., & Crandell, J. D. (2010). Vocabulary practices in prekindergarten and kindergarten classrooms. *Reading Research Quarterly*, *45*(3), 318–340. https://doi.org/10.1598/RRQ.45.3.3

Silverman, R., Proctor, C. P., Harring, J. R., Doyle, B., Mitchell, M. A., & Meyer, A. G. (2014). Teachers' instruction and students' vocabulary and comprehension: An exploratory study with English monolingual and Spanish-English bilingual students in grades 3-5. *Reading Research Quarterly*, *49*(1), 31–60. https://doi.org/10.1002/rrq.63

Stahl, S. A., & Fairbanks, M. M. (1986). The effects of vocabulary instruction: A model-based meta-analysis. *Review of Educational Research*, *56*(1), 72. https://doi.org/10.2307/1170287

Stake, R. (2000). Case studies. In N. Denzin & Y. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 435–454). Sage.

Swanborn, M. S. L., & de Glopper, K. (1999). Incidental word learning while reading: A meta-analysis. *Review of Educational Research*, *69*(3), 261–285.

Taboada, A., & Rutherford, V. (2011). Developing reading comprehension and academic vocabulary for English language learners through science content: A formative experiment. *Reading Psychology*, *32*(2), 113–157. https://doi.org/10.1080/02702711003604468

Varelas, M., & Pappas, C. C. (2006). Intertextuality in read-alouds of integrated science-literacy units in urban primary classrooms: Opportunities for the development of thought and language. *Cognition and Instruction*, *24*(2), 211–259. https://doi.org/10.1207/s1532690xci2402_2

Varelas, M., Pappas, C. C., & Rife, A. (2006). Exploring the role of intertextuality in concept construction: Urban second graders make sense of evaporation, boiling, and condensation. *Journal of Research in Science Teaching*, *43*(7), 637–666. https://doi.org/10.1002/tea.20100

Vitale, M. R., & Romance, N. R. (2012). Using in-depth science instruction to accelerate student achievement in science. *International Journal of Science and Mathematics Education*, *10*(2), 457–472. https://doi.org/10.1007/s10763-011-9326-8

Vygotsky, L. S. (1978). *Mind in society* (M. Cole, V. John-Steiner, S. Schribner, & E. Souberman, Trans.). Harvard University Press.

Vygotsky, L. S. (1986). *Thought and language* (A. Kozulin, Trans.; Translation newly rev. and edited). MIT Press.

Wade, S. E., & Reynolds, R. E. (1989). Developing metacognitive awareness. *Journal of Reading*, *33*(1), 10.

Wang, J., & Herman, J. (2006). *Evaluation of Seeds of Science/Roots of Reading project: Shoreline science and terrarium investigations* [Data set]. CRESST, UCLA. https://doi.org/10.1037/e644802011-001

Wanzek, J. (2014). Building word knowledge: Opportunities for direct vocabulary instruction in general education for students with reading difficulties. *Reading & Writing Quarterly*, *30*(2), 139–164. https://doi.org/10.1080/10573569.2013.789786

Wasik, B. A., & Bond, M. A. (2001). Beyond the pages of a book: Interactive book reading and language development in preschool classrooms. *Journal of Educational Psychology*, *93*, 243–250.

Wasik, B. A., Bond, M. A., & Hindman, A. (2006). The effects of a language and literacy intervention on Head Start children and teachers. *Journal of Educational Psychology*, *98*(1), 63–74. https://doi.org/10.1037/0022-0663.98.1.63

Wasik, B. A., & Hindman, A. H. (2014). Understanding the active ingredients in an effective preschool vocabulary intervention: An exploratory study of teacher and child talk during book reading. *Early Education and Development, 25*(7), 1035–1056. https://doi.org/10.1080/10409289.2014.896064

Wasik, B. A., Hindman, A. H., & Snell, E. K. (2016). Book reading and vocabulary development: A systematic review. *Early Childhood Research Quarterly, 37*, 39–57. https://doi.org/10.1016/j.ecresq.2016.04.003

Watts, S. M. (1995). Vocabulary instruction during reading lessons in six classrooms. *Journal of Reading Behavior, 27*(3), 399–424. https://doi.org/10.1080/10862969509547889

Windschitl, M., Thompson, J., Braaten, M., & Stroupe, D. (2012). Proposing a core set of instructional practices and tools for teachers of science. *Science Education, 96*(5), 878–903. https://doi.org/10.1002/sce.21027

Wise, C. N. (2019). *Assessment and instruction for developing second graders' skill in ascertaining word meanings from context* [Unpublished doctoral dissertation]. University of Michigan.

Wright, T. S. (in press). *A teacher's guide to vocabulary development across the day (K-3)*. Heinemann.

Wright, T. S. (2014). From potential to reality: Content-rich vocabulary and informational text. *The Reading Teacher, 67*(5), 359.

Wright, T. S. (2018). Reading to learn from the start: The power of interactive read-alouds. *American Educator, 4*, 18.

Wright, T. S., & Domke, L. M. (2019). The role of language and literacy in k-5 science and social studies standards. *Journal of Literacy Research*. https://doi.org/10.1177/1086296X18821141

Wright, T. S., & Gotwals, A. W. (2017). Supporting kindergartners' science talk in the context of an integrated science and disciplinary literacy curriculum. *The Elementary School Journal, 117*(3), 513–537.

Wright, T. S., Gotwals, A. W., Anderson, B. E., & Edwards, K. D. (2017). *Supporting classroom discourse during primary grades science instruction: A review of research*. Literacy Research Association Annual Conference, Tampa, FL.

Wright, T. S., & Neuman, S. (2014). Paucity and disparity in kindergarten oral vocabulary instruction. *Journal of Literacy Research, 46*(3), 330–357. https://doi.org/10.1177/1086296X14551474

Zipke, M. (2007). The role of metalinguistic awareness in the reading comprehension of sixth and seventh graders. *Reading Psychology*, *28*(4), 375–396. https://doi.org/10.1080/02702710701260615

Zipke, M. (2008). Teaching metalinguistic awareness and reading comprehension with riddles. *The Reading Teacher*, *62*(2), 128–137. https://doi.org/10.1598/RT.62.2.4

Zipke, M., Ehri, L. C., & Cairns, H. S. (2009). Using semantic ambiguity instruction to improve third graders' metalinguistic awareness and reading comprehension: An experimental study. *Reading Research Quarterly*, *44*(3), 300–321. https://doi.org/10.1598/RRQ.44.3.4

Zipoli, R. P., Coyne, M. D., & McCoach, D. B. (2011). Enhancing vocabulary intervention for kindergarten students: Strategic integration of semantically related and embedded word review. *Remedial and Special Education*, *32*(2), 131–143. https://doi.org/10.1177/0741932510361262