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An Inquiry Into How Fourth-Grade Students Investigate Their Theories For Learning Scientific Vocabulary

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AN INQUIRY INTO HOW FOURTH-GRADE STUDENTS INVESTIGATE THEIR THEORIES FOR LEARNING SCIENTIFIC VOCABULARY

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of the requirements for the degree of

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in

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by

Tatiana F. Miller

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ABSTRACT

AN INQUIRY INTO HOW FOURTH-GRADE STUDENTS INVESTIGATE THEIR THEORIES FOR LEARNING SCIENTIFIC VOCABULARY

By

Tatiana F. Miller

While instructional practices that engage students in developing metacognitive skills and capabilities are likely to be beneficial for all students, they may be particularly beneficial for students who are traditionally less well-served by schools. In this research, two culturally and linguistically diverse groups of fourth-grade students engaged in developing and investigating their theories of how they learn scientific vocabulary in an ecology unit of study. Through collaborative inquiry, students tested and refined their learning theories, while simultaneously developing metacognitive capabilities and theories for when and how to apply them in order to meet a variety of learning goals. Collaborative inquiry served as the pedagogical approach for engaging students in investigating their own theories, which in turn promoted their learning of and participation in academic discourse, in addition to their learning scientific vocabulary, science content, and inquiry practices. Employing a quasi-experimental design, and using a mixed-methods approach, this study investigated changes in students' orientations towards the complexity of word learning and their metacognitive capabilities. Through collaborative inquiry into their own theories of how they learn, students developed awareness and capabilities for taking charge of and improving their own learning in ways that extended beyond learning new words in science, and which could be useful in their lives and in developing their sense of self-efficacy. Informed by sociocultural and sociocognitive theories of learning, this study contributes to a theory of learning and a vision for how inquiry, metacognition, and language may be synthesized within a sociocultural and sociocognitive framework. It also helps to advance a vision for designing curriculum and learning environments that foster metacognitive development and students' feelings of self-efficacy. Findings suggest that synthesizing inquiry, metacognition, and word learning within a sociocognitive, collaborative learning framework is beneficial for developing students' metacognitive capabilities, word learning theories, and word consciousness, while advancing a pedagogical approach which helps students become self-efficacious and self-directed learners.

DEDICATION

To My Father,

John R. Frederiksen

Who instilled in me a curiosity
about how people learn
throughout my life—
as a child, a student, a teacher, a collaborator, a researcher, and as a parent

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An Inquiry Into How Fourth-Grade Students Investigate Their Theories for Learning Scientific Vocabulary

The literature on sociocultural and sociocognitive theories of learning, metacognition, and vocabulary learning suggests that the domain of word learning is fertile ground for engaging students in inquiry into their own ways of learning. There is evidence to suggest that engaging students in collaborative inquiry into their own theories of learning will assist in the development of metacognitive and metalinguistic skills and capabilities, as well as knowledge of inquiry practices. Flavell (1979) defines metacognition as knowledge of one's thinking and cognition, and self-regulation and monitoring of one's own thinking and comprehension. Engaging students in inquiry-oriented curriculum that enhances metacognition benefits students' learning, and has been found to be especially beneficial for lower achieving students (Palincsar & Brown, 1984; White & Frederiksen, 1998). Further, such forms of learning have the potential to promote students' feelings of self-efficacy as they become more proficient in 'learning how to learn,' particularly in learning how to learn and use forms of academic language and vocabulary, which are valued both by schools and other institutions in society.

It is by engaging in collaborative inquiry within a community of practice that students have the opportunity to develop a language of practice in the context of use, and acquire tools of a learning community by reflecting on their own learning within that community. In this study, vocabulary knowledge and science provided the context for such collaborative inquiry to occur, as students encounter an abundance of new academic language and concepts in science as a content area of study (Scott, 2004). Using this context and approach created the opportunity to closely examine students' development of metacognitive capabilities as they investigated their own theories for how they learned new words.

A learning communities approach employing collaborative inquiry entails students undertaking a shared inquiry, collectively pursuing research by investigating theories in light of questions that the learning community considers. Such an approach to teaching and learning provides a condition for developing cognitive apprenticeships situated in authentic activity, including opportunities to compare alternative interpretations, identify misconceptions or inaccurate strategies, and to negotiate meaning as a group. The aim of learning communities is to engage students in cultural practices and roles similar to mature communities of practice in society, where students simultaneously build on and advance collective knowledge and become expert learners (Bielaczyc & Collins, 1999). In the process of constructing knowledge, a community develops a language of practice, and with it, conceptual understanding in the context of authentic activity (Brown & Palincsar, 1989). Through collaborative inquiry as a framework and approach for learning, students become explicitly aware of the goals, strategies, and knowledge valued in the community while simultaneously developing metacognitive capabilities, knowledge, and awareness.

The purpose of this study was to create and test a curricular approach that engaged students in collaborative inquiry to investigate their theories of how they learn words in science. This study investigated whether and how students developed and refined theories of word learning through a collaborative inquiry process. Drawing upon their prior knowledge and experiences, students developed conceptual models and theories of how they learned words and concepts, and went on to evaluate them by carrying out experiments that tried out different ways of learning words. Vocabulary learning in science was chosen as the domain for students' inquiry as students for a number of reasons. All students have experience learning new words in their lives, and thus may draw upon their prior knowledge and experiences readily in theorizing about how they learn them. Students from culturally and linguistically diverse backgrounds could also draw upon their linguistic funds of knowledge in constructing theories and, in so doing, it was hypothesized that their diverse experiences would contribute to the learning of all students in the community. Furthermore, word learning is fertile ground for students to become aware of their own metacognition, as they reflect on and examine their own learning processes and develop capabilities as more self-aware learners. Finally, students encounter a plethora of new words in science, and learning new concepts in science often accompanies learning new scientific terms or words representing these new concepts. The underlying hypothesis guiding this work is that the process of students developing, testing, and refining their own learning theories in light of evidence would help them to develop and improve their metacognitive awareness of, and capabilities for, managing their strategies for learning with respect to different learning goals.

Theoretical Framework

Vygotsky's (1986) social constructivist theory of learning synthesizes the use of language, tools, and external signs in a social context, and represents the process of internalization of cultural forms of behavior as emerging from socially rooted and historically developed activities. In this way, cognitive processes are acquired within a social context in the presence of expert scaffolding performed by a more knowledgeable other. Studies of learning based on a sociocognitive theoretical framework seek to characterize the learning processes of groups engaged in collaborative learning. An example is Palincsar and Brown's (1984) research on Reciprocal Teaching, in which students were introduced to comprehension strategies through playing roles. What is distinctive in their research, and other research that builds on Vygotsky's theory, is the significance they place on the social aspect of learning, investigating the social process and roles individuals played while learning. Theories of situated cognition advanced by Brown, Collins, and Duguid (1989) argue that activities of a domain are framed by their culture, and that their meaning and purpose are socially constructed "through negotiations among present and past members" (p.34). Theories of learning that involve approaches such as cognitive apprenticeship (Collins, Brown, and Newman, 1989) regard learning as embedded in activity that makes use of the social and physical context of activity. Lave and Wenger's (1991) notion of situatedness regards learning as "an integral and inseparable aspect of social practice" (p.31), which is central to their theory of legitimate peripheral participation in communities of practice. Rogoff's idea of guided participation builds on Vygotsky's concept of the zone of proximal development, suggesting that, "both guidance and participation in culturally valued activities are essential to children's apprenticeship in thinking" (Rogoff, 1990, p.8). These theoretical orientations illustrate a sociocognitive view aligned with understandings of cognition and learning from research, which support hypotheses for how different roles or forms of participation might be enacted as a process of enculturation into a learning community.

Brown (1992) reflected on how her approach to studying students' learning shifted, from research designs and methodologies for testing particular instructional materials and activities to conducting design experiments in classrooms (Collins, 1992; Brown, 1992). In these design experiments, she pursued the goal of transforming classrooms from worksites in which students completed tasks assigned and managed by teachers, into communities of learning where students were given significant opportunity to take charge of their own learning through setting up a classroom ethos which fostered reflective learning. In conducting design experiments, Brown conceived of all aspects of classroom life, including curriculum, teacher training, and assessment, as synergistic. In her research she sought to characterize the processes of learning and conceptual change of both teachers and students. At the same time she tested hypotheses about the role technology, curriculum, and assessment played in achieving these aims. Her goal was to work toward a theoretical model of learning and instruction rooted in a firm empirical base, by introducing interventions and demonstrating how they worked through the use of both quantitative and qualitative data analyses as complementary methods. Combining statistical analyses of outcome measures with rich qualitative data analyses (such as arising from discourse, interviews, and student artifacts) provides the inquiry tools needed for investigating sociocognitive theories of learning (Collins, 1992; Brown, 1992).

In this study, building on sociocultural and sociocognitive theories of learning, I contribute to the advancement of a theory of learning in which inquiry, metacognition, social constructivism, and word learning are not only aligned, but are understood as interdependent and synergistic. To achieve this aim, I work within a learning environment that engaged students in collaborative, reflective, self-directed learning. Rather than measuring success by looking exclusively at the skills and knowledge students acquired, I sought to understand and characterize how to foster students as self-conscious learners, who have, use, and know when and how to apply strategies and metacognitive capabilities for learning. These capabilities form through the development of metacognitive skills and capabilities, such as monitoring and controlling one’s learning processes, and deliberately selecting, applying, and evaluating strategies for learning. Such capabilities, together with a growing knowledge and awareness of ways of learning, help shape students' epistemological beliefs, approach to learning, and feelings of self-efficacy.

With the goal of fostering students' development of expertise in learning in the context of learning words, vocabulary learning was framed within a broader goal structure of fostering students as self-efficacious learners. This built on a theoretical link between the body of research on word learning and research on metacognition, which provides a rationale for developing students' metacognitive capabilities as an essential aspect of word learning. I explored whether students can acquire some of the processes and skills of expert word-learning performance through developing metacognitive capabilities underlying word learning, capabilities arrived at by engaging in collaborative inquiry into their own theories of learning words.

Schoenfeld (1987) argued that student interest and motivation are related to their epistemological beliefs about learning, supporting the notion that these beliefs should be addressed within the curriculum. In this study, I examined epistemological beliefs by applying an inquiry framework for learning that engaged students in an investigation of their own theories of learning. By conducting inquiry into their theories for learning words, students reflected on their own epistemological beliefs about how they learn new words and what it means to know a word. They also identified theories they have about the different ways they learn words and concepts based on their prior knowledge and experiences. Furthermore, they investigated and critically evaluated which of their theories of word learning were more effective for accomplishing particular learning goals. These activities influenced students' epistemological beliefs, as they formulated their theories of how they learn, reflected on evidence in investigating their theories, and further refined them.

The role of collaboration in learning and developing a community of practice is central to my theoretical framework, just as it is essential to the process of inquiry. Collaborative inquiry provides opportunities for many of the characteristics of situated learning described by Brown, Collins, and Duguid (1989) to occur. These include opportunities for identifying misconceptions or inaccurate strategy use, negotiating meaning as a group, and building a language of practice and conceptual understanding, all in the context of their use while engaging in authentic activity. This process of enculturation into a community of practice through collaborative, authentic, situated activity aligns with characteristics of cognitive apprenticeship described by Brown et al. (1989): "Enculturating through this activity, they acquire some of the culture's tools - a shared vocabulary and the means to discuss, reflect upon, evaluate, and validate community procedures in a collaborative process" (p.38).

Review of Literature

In this study, collaborative scientific inquiry functions as an underlying framework and approach for promoting the development of students' metacognitive capabilities central in higher-order reasoning. In this next section, I present a review of research that has contributed to an understanding of how best to foster metacognitive capabilities in students. This includes the pioneering work of how metacognitive capabilities were first explicitly fostered in classroom contexts, and how studies then evolved to foster a particular learning environment and pedagogical approach in which students forged communities of learners engaged in shared, collaborative inquiry. Finally, in light of this study's hypothesis that engaging students in an inquiry into their own theories of how they learn words may be used as a pedagogical approach for fostering metacognitive development, students' capabilities in developing awareness and control of their own metacognition and the relationship this has to learning, motivation, and feelings of self-efficacy is examined.

Instructional Approaches Fostering Metacognitive Capabilities

Following early studies establishing the efficacy of fostering students' metacognitive skills in laboratory settings, researchers became more interested in the role that social context plays in learning in classrooms. This is exemplified in the work of Palincsar and Brown (1984), Cross and Paris (1988), and in research into self-regulated learning (e.g. Delcos & Harrington, 1991; Zimmerman, 1998) in which researchers began to consider how to systematically investigate and characterize social interactions effective in fostering students' development of metacognitive capabilities. In Palincsar and Brown's (1984) model of Reciprocal Teaching, for example, metacognitive strategies used by a more expert teacher were modeled and introduced to students as a set of roles, which they then used in discussions to question one another about text. In this scaffolded, collaborative group context, students acquired skills that supported their reading comprehension while coming to understand, use, internalize, and transfer these sets of strategies. Meanwhile, the strategies themselves served as cultural tools for learning, with the purpose of fostering students' metacognitive capabilities and improving their academic skills.

Studies of innovative learning environments aimed at fostering a community of learners also explored the role of social interaction and metacognition in learning (Brown & Campione, 1996; Scardamalia & Bereiter, 1994; Bielaczyc & Collins, 1999). Such studies advanced a sociocognitive theory of learning in which knowledge is regarded as being constructed in a social context involving collaboration and expert scaffolding, mediated by context, activity, discourse, and cultural tools. These tools are diverse, and may include the use of computer technology (White & Frederiksen, 1998; White, Frederiksen & Collins, 2009; Scardamalia & Bereiter, 1994), live experts, such as cross-age student teachers and visiting experts (Brown & Campione, 1996), and roles introduced for students to play (Palincsar & Brown, 1984; Herrenkohl, et al., 1999).

Goals of such communities of practice include promoting the development of multiple forms of distributed expertise and collective knowledge in a community of learners resembling those of mature thinkers and practitioners. Metacognitive capabilities are considered critical in developing expertise, not only important for individual development, but also for collaborative knowledge-building within a community. Building on theories of cognitive apprenticeship (Collins et al., 1989) and situated cognition (Brown et al., 1989), such a context provides opportunities for making metacognitive capabilities transparent and explicit, through modeling and scaffolding such capabilities and processes for students, so they may develop and use such processes themselves both in socially constructing knowledge and in their own individual learning. Communities of practice, such as those constructed in Brown and Campione's Fostering Communities of Learners (FCL) (1996) and Scardamalia and Bereiter's Knowledge Building Communities (CWISE) (1994), are metacognitive environments where reflection on what is learned, how it is learned, and why it is learned serve as a foundation for all activity. Community goals, purposes, processes, and theories themselves become objects for collaborative reflection in these environments. Inquiry provides a framework for facilitating such reflection and serves as a central activity for learning within communities of practice, as it necessarily involves metacognitive processes, including those that are regarded as the keystone of advanced scientific thinking, such as theory-evidence coordination.

Developing knowledge and awareness of one's epistemological beliefs, including what it means for one to know and learn in a domain, is also found to involve metacognitive abilities and to have a strong influence on students' learning, motivation, and self-efficacy (Schraw et al., 2006; Schoenfeld, 1987). Research has shown that students not only have theories about how they learn, but they may develop awareness of their theories for learning as well. For instance, Brown (1984) notes that learners' can be aware of their own knowledge, are able to use knowledge flexibly, and can “mention as well as use” their knowledge. Hofer and Pintrich (1997) review studies investigating individuals’ theories and beliefs about knowing, and how epistemological beliefs become part of and influence cognitive processes of thinking and reasoning. In considering how epistemological assumptions influence thinking and reasoning processes with a focus on reflective judgment and skills of argumentation, King and Kitchener (1994) build on Dewey’s notion of reflective thinking (1933; 1938), and find that reflective judgment “is an ultimate outcome and development endpoint of reasoning and the ability to evaluate knowledge claims” (Hofer & Pintrich, 1997, p.99).

Herrenkohl and colleagues (1999) believe students’ theories and epistemological understanding play an important role in science learning, especially in developing an understanding of the relationship between theory and evidence and that science involves debating over evolving theories (Herrenkohl, et al., 1999). In recognizing a growing consensus over the purposes, methods, and values of scientific inquiry, they see engaging in reflection on theory as a cornerstone of development of knowledge of inquiry, and students’ learning in science. Engaging children in reasoning about their theories is also central in FCL (Brown & Campione, 1996), which builds on students’ theories, initially capitalizing on students’ functional reasoning and their over-reliance on mechanistic causality, and facilitating the refinement of their theories over time as students move through the developmental corridor of FCL. Encountering issues of variability, uncertainty, probability, and chance, students develop increasingly sophisticated theories that they test and weigh against alternative theories, explanations, and evidence. In this work, the processes of students becoming aware of and reflecting on their own and others' theories are central to the learning process across grade-levels and curricular units.

Wellman (2002) reviewed studies of children's metacognition and theories of mind, which demonstrate children's capabilities in becoming skillful in applying an awareness of mind to the job of using one's mind (Kuhn, 1999). Wellman (2002) argues that children become increasingly proficient in generating, using, and evaluating strategies for accomplishing cognitive tasks, and increasingly accurate in monitoring their own states of knowledge. Flavell (1999) also observed that young elementary school children are capable of being aware of and knowing about their own process of learning. He argues that children's awareness of actions being driven by intentions and goals is an important marker in theory-of-mind development, necessary for developing self-regulating behavior and executive control, as children come to understand that people not only choose to act, they deliberately plan and try to act in accordance with their goals. Finally, Schraw and Moshman (1995) proposed a framework for understanding theories about one's own cognition, considering how individuals consolidate different kinds of metacognitive knowledge and regulatory skills into systematized cognitive frameworks they call "metacognitive theories." They noted that skilled learners possess declarative, procedural, and conditional knowledge about their cognition, and that young children can reflect on their own cognition, and can demonstrate and use metacognitive knowledge even when it is not easily stated. They suggest such knowledge need not be 'statable' to be useful, and that conscious access to it facilitates one's thinking, self-regulation, and awareness of it.

Metacognition and Vocabulary Learning

An aspect of metacognition that is ripe for investigation is that of how to develop students' metacognitive and metalinguistic awareness and capability in the domain of word learning. Nagy and Scott (1990) noted that most research in this area has focused on inferring word meanings from context, and that interventions aimed at training students in this area have been only modestly successful. Nagy and Scott also suggest that more general metacognitive skills (such as comprehension monitoring, being aware of when to apply word learning strategies, and monitoring whether a word is unknown or important for understanding) contribute to word learning. They argue that since the multiple dimensions of word knowledge are rarely conveyed in definitions alone, in order for students to take responsibility as active learners of words, they need information about the nature of word knowledge and processes for learning new words; in other words, they need metacognitive and metalinguistic ability in the domain of word learning (Nagy & Scott, 2000). They advance 'word consciousness' as an important goal for vocabulary instruction, noting that its nature, like word knowledge, is complex, multifaceted, and has seldom been explicated.

Scott (2004) further clarified the concepts of metacognition and word consciousness, suggesting word consciousness can be thought of as "the metacognitive or metalinguistic knowledge that a learner brings to the task of learning." She explains word consciousness is "an interest in and awareness of words," noting this knowledge is not necessarily conscious, and that it is comprised of several types of metalinguistic awareness, such as morphological, syntactic, and semantic awareness, which may help students not only acquire specific words, but also acquire a facility for learning words in general (Scott, 2004). Scott suggests this knowledge is generative, consisting of knowledge and dispositions that have the potential to enhance students' word learning in multiple domains (Scott, 2004).

Anderson and Nagy (1992) proposed fostering word consciousness in students as a goal for vocabulary instruction. Blachowicz and colleagues (Blachowicz, et al., 2006) also noted that there is a growing consensus on including word consciousness as a necessary component of a comprehensive and integrated program of vocabulary instruction. They also point out the need for research to further investigate the role of metacognition in word learning and instruction, and the importance of teachers' understanding of metacognitive aspects of vocabulary learning in making curricular and pedagogical decisions regarding vocabulary instruction (Blachowicz, et al., 2006). The RAND report on research for improving reading comprehension noted that word consciousness is a potentially important element in promoting vocabulary growth, however, they also pointed out a lack of research on its measurement or its effect on vocabulary learning. They speculate this may be because the constructs that make up word consciousness are not necessarily related to one another, and little is known about how they relate to one another or to vocabulary growth (RAND Reading Study Group, 2002).

Anderson and Nagy's (1991) theoretical consideration of what constitutes word meaning leads them to suggest that developing students' metacognitive awareness in learning vocabulary is important. For instance, they suggest the possibility of attributing children's rapid early word growth to the acquisition of a conceptual structure of naming which allows them to quickly learn new words for already-known concepts. This begs the question of what the potential would be for students' word learning if they were to develop metacognitive awareness of different conceptual models and strategies for learning different types of words and aspects of word knowledge in different contexts. Anderson and Nagy (1991) also acknowledge that students' collaboratively constructing word meanings in class discussions is a productive process. They explain that in such a process, students gain insight into aspects of word knowledge that are otherwise tacit. This is consistent with models of cognitive apprenticeship (Collins, et al., 1989), in which expert cognitive and metacognitive processes that are otherwise tacit are made explicit and transparent for students through modeling, thinking aloud, coaching, and fading, with students beginning to try them out, appropriating them, and using them on their own. While Anderson and Nagy stress that making knowledge of word meanings explicit is a pedagogically useful approach, general metacognitive strategies can also be useful in constructing word meanings and can be made explicit as well. Metacognition is also central in Anderson and Nagy's (1991) goals for vocabulary learning, particularly in the flexible use and application of word knowledge. It would seem that this requires metacognitive awareness of the multiple ways in which one acquires such knowledge to begin with.

Finally, Scott (2004) highlights specific areas that appear fruitful for investigating a collaborative inquiry approach to metacognitive development in the domain of word learning. Some examples include developing awareness of strategies students already use but don't realize they use, such as identifying word parts as clues, applying knowledge of syntax combined with context and morphology to discover a word's meaning, and investigating language used by authors as models or "gifts of words," which students then can incorporate into their own writing. Becoming aware of different strategies for accessing existing word knowledge could help students become more strategic in applying them, which could potentially increase students' efficiency and self-efficacy in learning new words. Other examples Scott offers are developing students' concept of a word, and engaging students in reflective discussions in which they talk and think about words and what it means to know a word, and reflect on the different uses of words as tools for communication. Scott recommends strategies that seem especially useful for English Learners (ELs), like paying attention to cognates. Discussion of precise word choice as a writer's tool also draws on metacognitive capabilities, as students think of writing as a cognitive process as well as a self-regulated activity including planning, revision, reflection, and self-evaluation.

Some studies of vocabulary instruction have focused on teaching students generalizable strategies for learning new words, with contextual analysis being the most broadly studied. Graves (1986) and McKeown et al. (1985) both note that the effectiveness of such approaches vary depending on how outcome variables are measured and different learning goals. Some studies have established the efficacy of introducing students to metacognitive strategies for learning new words through explicit instruction, with findings showing transferable gains in vocabulary knowledge, reading comprehension, and improved accuracy in identifying unknown words as an indicator of monitoring word knowledge while reading (Boulware-Gooden et al., 2007; Lubliner & Smetana, 2005). Lubliner and Smetana (2005) concluded that vocabulary acquisition of low-performing students could be accelerated when self-monitoring and self-regulating skills are developed.

Research into instructional approaches specific to the vocabulary development of students who are ELs suggests that many of the approaches that are successful for native English speakers are also effective for ELs. Some of these include presenting words in meaningful contexts, engaging students in lessons that motivate students and encourage participation, providing instruction that is rich and in-depth, providing repetition and review, engaging students in lessons involving discourse around text, developing vocabulary study that builds on students' background language, previewing words in the home language and identifying cognates, engaging students in learning to apply word learning strategies such as morphological analysis, and ensuring that lessons involve scaffolding such as simplified syntax, visual materials, or oral language practice activities (Helman, 2008). Developing and capitalizing on bilingual students' metacognitive and metalinguistic capabilities and awareness may also be key in promoting their vocabulary development. Strategies unique to students' bilingual status, including code-mixing, translating, and using cognates as a tool for troubleshooting unknown words while reading, were found to be used by successful bilingual readers (Garcia, 1998). Meanwhile, since actual use of a cognate strategy was found to be limited despite a high level of awareness, a cognate strategy appears to be an underutilized strategy (Garcia & Nagy, 1993; Garcia et al., 1998; Flinspach, Scott, Samway & Miller, 2008). This, along with research demonstrating the potential efficacy of employing a cognate strategy in instruction, has implications for future research suggesting that metacognition plays an important role in second-language vocabulary learning and instruction.

Finally, research in vocabulary and science education suggests a need for content area teachers to develop an awareness of words that need further instruction, including words more often found in academic settings and texts, and words that represent concepts specific to an academic discipline or topic. Different types of words are also found to require different types of instruction. For example, semantic feature analysis and building background knowledge have been found effective for introducing new concept words (Graves, 2008; Nagy, 1988; Rupley, Logan & Nichols, 1998). Additionally, contemporary goals of vocabulary learning and science education include the broader aim of enculturating students into a community of practice in which students learn the language of science by acquiring its discourse in the context of its use (Rosebery, et al., 1992; Gee, 2008; Snow, 2008; Frederiksen & White, 1998). Gee (2008) argues students need to learn, understand, and value an identity of *being* a scientist in order to learn science, as scientists' ways of using language and other representational tools, such as equations, models, and theories that help them do their work, are integrally connected to their identity as scientists (Halliday & Martin, 1993). Developing a language of practice in science requires students to engage in and understand the authentic practices of scientists, as language forms and secondary discourses reflect ways of thinking in a community of practice. Through explicitly focusing on the discourse of science by engaging students in reflective discussion and analysis of its language forms and how they relate to the purposes and goals of practice, academic vocabulary will come to have a shared meaning in the context of authentic and collaborative inquiry. Goals of vocabulary instruction would be for students to come to understand ways in which language serves as a cultural tool for a community of practice, and that this entails acquiring an identity within the community and a shared language for working towards accomplishing its goals.

Given the literature reviewed above, engaging students in collaborative inquiry into their own theories of learning scientific vocabulary shows promise as a pedagogical approach for fostering students' metacognitive capabilities and self-efficacy. The body of research presented shows that students engaging in collaborative inquiry develop metacognitive capabilities as they theorize, reflect on and evaluate feedback, and assume roles that support the coordination of theory and evidence while reasoning and constructing scientific arguments (Herrenkohl, et al., 1999; Kuhn, 2000; White & Frederiksen, 1998; White, et al., 2009). Furthermore, we see how research into children's epistemological beliefs and theories of mind shows that, not only do children have theories about their own cognition, these theories may themselves develop and influence their learning – with more sophisticated theories approximating processes of scientific inquiry. Taken together, this research shows how fostering students' metacognitive capabilities is central to their becoming expert learners who are self-aware in their reflective judgments and reasoning. This study combines and expands the knowledge base in these fields of research by engaging students in conducting collaborative inquiry into their own theories for learning scientific vocabulary, providing students with the opportunity to develop a critical and sophisticated stance towards their own epistemological beliefs, as they revise their theories-in-action in the face of theory-evidence coordination, and simultaneously develop their identity as scientists by appropriating and using the cultural tools and language of science.

Research Design

Purpose

The purpose of this study is to test an approach for teaching and learning that integrates inquiry, metacognition, science, and vocabulary learning by engaging students in a collaborative inquiry into their own theories for learning scientific vocabulary. My general hypothesis is that students' metacognitive development is powerfully and synergistically fostered in a learning context in which students' develop, test, and refine their theories of how to learn scientific vocabulary, through conducting inquiry on their own learning of ecological concepts and vocabulary. The expected outcomes under this hypothesis are that: (1) students develop, refine, and improve their theories of learning scientific concepts and vocabulary by constructing cognitive and sociocognitive theories of how they learn them; (2) the theories students construct are worthwhile theories for how to learn words and are rooted in their own ideas, prior knowledge, and experiences; and (3) by participating in this process, students develop metacognitive capabilities for applying their theories. In order to understand the nature of the development of students' learning theories and their metacognitive awareness and capabilities for applying them, I focus on understanding the process of how such development occurs in the context of the classroom, and explore the role a teacher can play in fostering such accomplishments and capabilities. Finally, as ELs and students whose heritage language differs from English are a growing population in schools, and because learning in and acquiring two languages affords opportunities for reflecting on how one learns words in each and across languages, another expected outcome might be that the nature of such students' theories and metacognitive capabilities will differ qualitatively from those of students who speak only one language. This hypothesis also predicts that such a pedagogical and curricular approach will foster students' development of epistemological beliefs about learning in general, word consciousness and conceptual understanding of vocabulary learning in the context of science, and knowledge of scientific inquiry. Research questions guiding the investigation are:

1. Does a collaborative inquiry-learning environment in which students form and test their theories for learning new words facilitate the development of students' metacognitive capabilities?
    a) Do students' theories for learning words become more coherent and integrated over the course of their inquiry?
    b) What forms does students' metacognitive growth take? For example, do students develop a greater awareness of their learning theories, or a greater capability for managing their strategies for learning words?
    c) Is the learning environment equally effective for all students? In particular, is it effective for students from culturally and linguistically diverse backgrounds?

2. How does such an instructional environment foster the development of these metacognitive capabilities?
    a) What types of discourse practices and processes contribute to student learning?
    b) What teaching practices foster students' development of these capabilities?

Methodology

This research studies an inquiry approach to learning, in which students investigate their own learning theories in small groups and in class discussions with careful scaffolding by the teacher and the use of the Web of Inquiry, a web-based software program (Frederiksen et al, 2015). The methodology used in this investigation includes multiple levels of analysis of both quantitative and qualitative data sources. One level of analysis assesses individual students, as well as looking specifically at students who are English Language Learners, in order to see changes in understanding of important ideas and concepts in the curriculum. Another level of analysis seeks to understand the processes by which important ideas are collaboratively constructed within the social context of the classroom, and calls for a detailed analysis of video of whole class and small group discourse. On a third level, this is participatory research, as I was both the teacher and the researcher for the study.

In order to understand whether the curricular and pedagogical approach had an effect on students' development, and in order to understand the process of how such development occurred in the context of the classroom, I utilized a multi-level mixed methods approach. Qualitative artifacts of students' work and data sources for the analyses included a researcher-developed assessment that captured students' theories about word learning, an exploration of the data from research groups' Web of Inquiry project reports, and videos of classroom discourse. Quantitative methods were used for testing changes in students' performance and for studying the effects of the curricular approach for English Proficient and English Learner students. Finally, several classroom discussions were analyzed to contextualize and further explore how ideas were introduced and picked up by participants and to describe discourse moves during teaching that supported student inquiry. In addition to the analysis of classroom discourse, there are also analyses of my own teaching practices and discourse moves as the teacher, implementing a form of participatory inquiry.

The Role of the Researcher in Conducting Participatory Research

My teaching experience and background knowledge of vocabulary and inquiry learning made me particularly well positioned to conduct this research. In part, this was a study of convenience, as I had been a fifth grade teacher at the school, and had friends teaching fourth grade in the first year of the study who were willing to grant me access to their classrooms. As a teacher from Ocean Park, the school where the study was conducted, I had five years of experience in teaching inquiry-based science as well as other subjects for fifth-grade students at the time of the study. Prior to the study, I had been a teacher participant in the National Science Foundation funded *Learning Inquiry through Reflective Assessment* (LIRA) Project (see Frederiksen at al., 2015). I also had a background in environmental and outdoor education with an undergraduate degree in Environmental Studies. Before teaching at Ocean Park, I spent four years teaching in the outdoor classroom as a naturalist field instructor for residential outdoor science schools in California. During that time I designed and taught experiential hands-on science and inquiry curricular programs for groups of fifth and sixth-grade students visiting for a week at a time from public schools located throughout the surrounding counties. I also had a Masters degree in Education and a California multiple-subject teaching credential with a cross-cultural language and academic development (CLAD) certification and experience developing and presenting environmental education programs for the National Park Service, the National Forest Service, and the Massachusetts Audubon Society. Finally, at the time of the study, I was a doctoral student serving as a Graduate Student Researcher for the Department of Education funded *Vocabulary Innovations in Education* (VINE) Project. In this project, a collaborative inquiry approach to professional development for teachers was co-constructed with teachers and researchers with the aim of fostering teachers' and their students' word consciousness (see Scott et al., 2012; Miller et al., 2010).

In this dissertation study, I designed and taught the curriculum both years. In year one, another classroom teacher was present and offered additional support to students while working in small research groups. In the second year, I went back to Ocean Park as a part-time fourth grade teacher and taught the class independently. Throughout this dissertation I refer to myself as both the researcher conducting the study, and the teacher.

To address concerns regarding potential bias in collecting and analyzing data from my own teaching, I recruited classes for comparison in the same school and grade level. I also removed identifying year and treatment condition from the data whenever possible before I coded the data. Careful attention was given to triangulating data and analyses of a number of different data sources using methods that were transparent with outside raters validating coding schemes. Specifically, after establishing pre-post results through quantitative and qualitative analyses, both quantitative analyses of qualitative data sources were conducted, as well as qualitative descriptive analysis of cases aimed at making pedagogical and discourse processes and practices transparent. The sections that follow explain more specifically how this methodological approach was carried out, and how it served to illuminate learning outcomes and processes by which they were achieved.

Context, Setting, and Participants

The study took place in culturally and linguistically diverse fourth-grade classrooms of 20 (year one) and 23 (year two) students in a Title I elementary school in a coastal community in California. Convenience sampling was used, as another teacher volunteered to participate with her class of students in year one. In year two, I was assigned a 20% teaching contract in the same school, and taught one day a week, sharing a class with the same teacher participant who volunteered with her class from year one, and who taught the remaining four days of each week. The unit of analysis consists of all students in the classroom (all students and families had given consent to participate). Given the diversity in the school and class makeup, ELs and lower-achieving students are subgroups of interest in the sample. Two other fourth-grade classes from the same school participated as comparison classes, one each year, with pretests and posttests administered to assess students' theories of word learning and knowledge of scientific inquiry practices.

Ocean Park Elementary[1] serves a diverse student population, and receives Title I federal funds since there are a considerable number of students from low-income backgrounds enrolled (59% of students received free or reduced lunch when the study was conducted). The school also serves a fairly large number of students who are designated as ELs, particularly children from Spanish-speaking homes. California law defines ELs as:

> Students for whom there is a report of a primary language other than English on the state-approved Home Language Survey **and** who, on the basis of the state approved oral language (grades kindergarten through grade twelve) assessment procedures and literacy (grades three through twelve only), have been determined to lack the clearly defined English language skills of listening comprehension, speaking, reading, and writing necessary to succeed in the school's regular instructional programs. (R30-LC)[2]

When the study was conducted, thirty-six percent of the students in the school were designated ELs, while 60% of students were reported as belonging to an ethnic group other than White, with Hispanic being the largest subgroup at 50%[3]. The percentage of ELs in the experimental class for both years was higher than the school

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[1] Pseudonyms are used throughout to protect the identity of participants

[2] Source: Glossary of Terms used in CBEDS and Language Census Data Reports, California Department of Education (2015)

[3] Source: School Profile, Education-Data Partnership, California Department of Education (2008)

average, with half of the class (50%) designated as ELs in year one, and 40% in year two, while the comparison classes more closely resembled the school average both years.

Prior to the first year of the study, Ocean Park was considered a ‘Program Improvement’ (PI) school under the No Child Left Behind Act, with ELs being the subgroup that did not meet goals for proficiency on state tests. In the first year of the study, ELs, along with all other subgroups, met target goals and the school’s PI status was “frozen.” In the second year of the study, all benchmarks for growth for all target groups were met, and the school was no longer considered PI. In the year following the study’s conclusion, the school returned to PI status. Ocean Park has a bilingual program in kindergarten through third-grade, and fourth-grade is the first year in which content-area and language arts instruction are conducted in English for all students. Students who participated in the bilingual program were integrated with students who did not participate in the bilingual program in all fourth-grade classes. Fourth-grade was also chosen for this project because, as Miller and Gildea (1987) found, “fourth grade is about when students see written words they have not heard in conversation, and it is at this point that it is generally assumed that something special must be done to teach children these unfamiliar words” (p.95-6).

Overview and Scope of the Study

The study took place over the course of two successive years in the same school. I also administered pretest and posttests to another fourth grade class at the same school both years, which served as comparison classes. In year one, the curriculum was implemented in 50-minute sessions held 2-3 times a week for approximately ten weeks while I, as the researcher, served as a “guest teacher” in another teacher’s fourth grade class. During lessons, I taught the class while the students’ classroom teacher observed. Both of the teachers assisted students during group work. In year two, the curriculum was implemented in hour-long sessions one day a week over the course of the school year. In year two I was a part-time teacher in the school, sharing a teaching contract and class with the same teacher whose class I taught in year one.

The purpose of conducting a multi-year study was to test the instructional approach and the way inquiry was presented and conducted in multiple classes. In both years, the pedagogical approach was similar, structuring inquiry around a topic and research design shared by the whole class, then having students pursue their inquiry in small groups, and eventually sharing and reflecting as a whole class. Having multiple classes allows me to make inferences about the success of the teaching approach with two groups of students, and provides a wider sample of student’s learning activities to analyze in studying how children come to develop theories of word learning and metacognitive capabilities for applying them. In addition, I tested a comparison class each year to obtain baseline assessments of students’ word learning theories and inquiry knowledge, and growth when students are receiving the regular curriculum.

Curricular Approach

Why science? Science was chosen as the domain for this study since it affords numerous occasions for introducing students to new words, particularly words that are infrequently used in day-to-day conversation and reading, as well as words that represent specialized content knowledge. As Scott (2004) suggests "teaching science concepts in elementary classrooms can introduce a plethora of new terms and build background knowledge at the same time." Core vocabulary words in science also frequently introduce concepts that are entirely new to students. My science education background also informs the curriculum, assessment, and pedagogical approach. The vocabulary words selected for the study represent concepts in ecology included in the fourth grade California science content standards (see Appendix A). Finally, conducting collaborative scientific inquiry offers students an opportunity to become a member of a community of practice, acquiring the discourse of science in the context of its use (Gee, 2008; Halliday & Martin, 1993).

Overview of student activities. The purpose of the curriculum was for students to come up with competing theories and strategies for learning new words in science that they then could test, followed by designing and implementing research to test them, analyzing data and refining their learning theories based on their findings. Students' inquiry was scaffolded by the Web of Inquiry software (Frederiksen et al., 2015), which is available to the public at www.webofinquiry.org. This web-based software also served as a pedagogical tool, scaffold, and resource for the teacher to use in planning instruction and in teaching (see Figure 1 for an example screen shot from the Web of Inquiry).

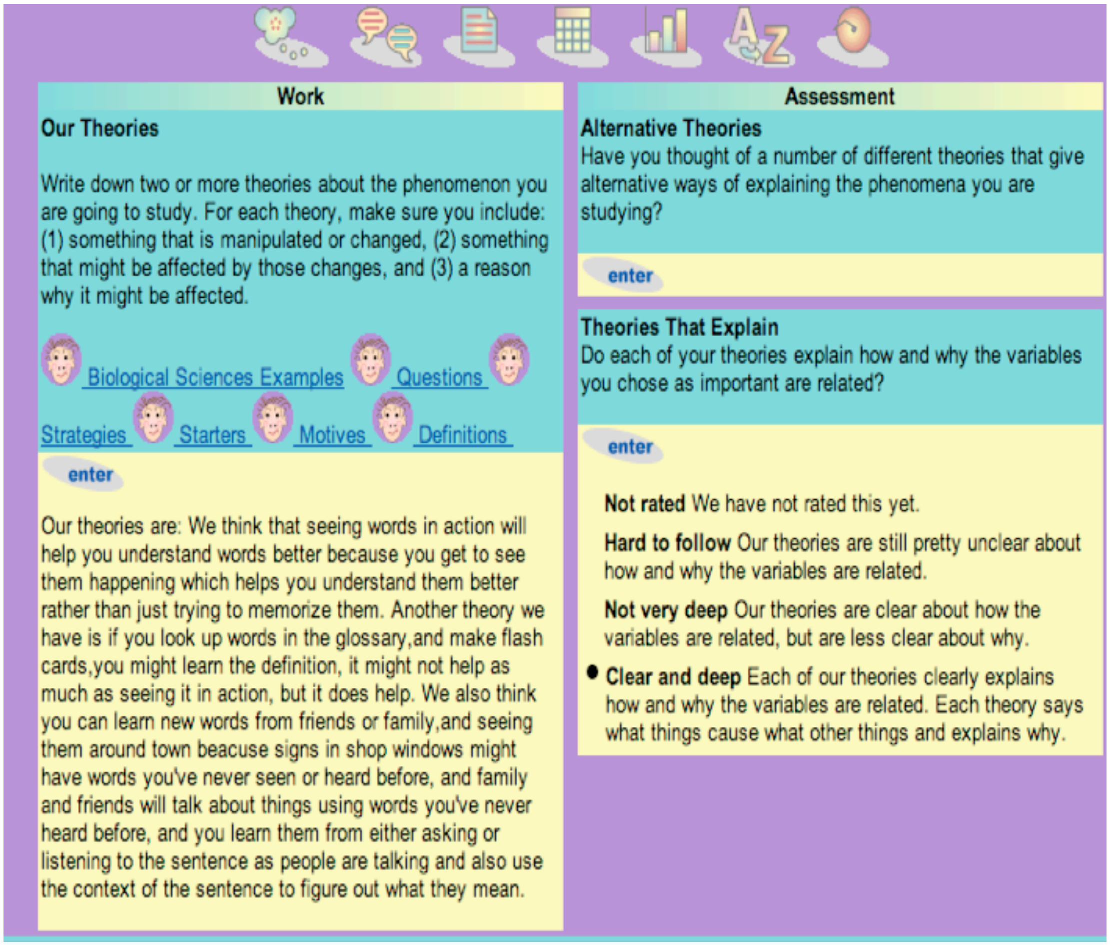


Figure 1. Questioning and Theorizing in the Web of Inquiry: Our Theories

Students began the curriculum by considering why people learn new words, when people need to learn new words, how people learn new words, and what it means to know a word, generating theories for word learning collaboratively in the context of whole class discussions. Three learning strategies, which tested different theories for learning new words in science proposed by students, were then agreed upon by the class as theories to be tested as a whole class. These were: (1) learning definitions of words by using a dictionary to make flash cards, (2) reading a science text containing the words, and (3) going on a field trip to see the words in action with an expert to point them out and explain them. Students then began their work in small collaborative groups of 2-3 students. In these groups, students considered the goal of how to best go about learning new words in science with respect to the three learning strategies the class would test. In their groups, students constructed specific theories, hypotheses, and research questions. Next, students, in whole class discussions, designed an investigation and assessment tools for testing the three learning approaches agreed upon by the class (flashcards, reading and field trips). Students then collected data by participating in each of the three learning strategies, and completing science vocabulary assessments and self-assessment as both pretests and posttests for each of the three learning approaches. They then scored these assessments using a rubric co-constructed by the class. Throughout this process, students continued to work in their small groups, documenting their research plan, how it would test their hypotheses, and creating summaries of their data.

Students then analyzed their data by comparing the class' average growth in word learning for each of the learning approaches, as well as by creating histograms of students' growth in word learning on vocabulary word assessments and self-assessments for each of the three learning approaches. They then identified patterns in their data by comparing growth and averages for the different learning approaches. This work was initially carried out as a whole class, with students sharing patterns and trends in their data, and continued in their small collaborative groups, as groups considered whether the data provided evidence in support of their various hypotheses. Students considered what would be the most effective learning approach supported by their evidence and developed a 'Current Best Theory' that explained their findings, first while having whole class discussions, and then in their small groups. Finally, students considered alternative theories that might still explain their findings, limitations in their research design, and future research questions that they could investigate to continue the cycle of inquiry given their refined theories and findings.

Identifying core vocabulary words. In order for the students to study their growth in vocabulary knowledge in science, 'core' vocabulary words were chosen to align with the California content standards for fourth-grade life sciences and the theme of ecology. While all of the words chosen represent important concepts in the content area, attention was paid to including different types of words as described in the vocabulary research literature. For instance, Scott (2004), in proposing a multifaceted approach to vocabulary instruction, suggests that different types of words require different types of instruction (such as learning a new label for a known concept versus learning a new concept and its label). Some considerations used in selecting words were whether words were likely to be entirely new concepts to students, requiring they build new knowledge of the word and meaning (such as *ecosystem*), whether words might require students to construct a new (scientific) meaning for a known word or concept (such as for the word *community*) prompting students to expand existing word schemas, and whether words might require attaching a new word label to a known concept (such as *carnivore)* (see Appendix B for lists of culled words and selection criteria). An effort was made to balance these types of words for each of the different learning approaches students tested. The students completed pretests to demonstrate their knowledge of the word before trying out a given learning approach, as well as posttests to show what knowledge was acquired after using each (pretests and posttests are described in detail in the section below).

Data Sources for Analysis

Using quasi-experimental and interpretive research methodologies, and a mixed-methods approach to data collection and analysis, data sources analyzed include pretest-posttest data for students' word learning theories, videotapes of whole class discussions and small group work, and students' inquiry project reports. Students' status as ELs is used in analyses as well. The data sources and assessments that align with each of the learning outcomes are summarized in Table 1 below:

TABLE 1
Data Sources and Assessments

Research Question Areas	*Data Sources*
Theories of Word Learning • Word learning theories • Process of developing theories • Role of the teacher in supporting development of word learning theories	• Word Learning Theories Assessment pretest and posttest, • Inquiry project reports • Video analysis
Metacognitive capabilities • Metacognitive capabilities in using and applying theories of word learning • Process of developing metacognitive capabilities • Role of the teacher in supporting development of metacognitive capabilities	• Word Learning Theories Assessment pretest and posttest, • Inquiry project reports • Video analysis
Theories and metacognitive capabilities of EL students compared with English Proficient (EP) students • Word learning theories • Metacognitive capabilities for using and applying theories	• Word learning Theories Assessment

Word Learning Theories Assessment. Each year, students in both the experimental and comparison group completed a Word Learning Theories Assessment (see Appendix C) as both a pretest and posttest. This assessment seeks to characterize students' theories and their conceptions of various competing theories of word learning. The assessment provided both qualitative and quantitative data, and has three parts. The first part of the assessment consists of four open-ended questions: (1) Why do people learn new words?, (2) When do people need to learn new words?, (3) How do people learn words?, and (4) What does it mean to know a word? These questions were intended to capture students' initial theories before they were exposed to questions in parts two and three of the assessment (which prompted their thinking about multiple, competing theories), providing a baseline for comparing how students' theories changed following the curriculum.

In the second part of the assessment, students were presented with statements about word knowledge and word learning and were asked to agree or disagree using a four-point Likert scale, and to explain their reasoning in an open response. In the third part of the assessment, students were shown video clips of scenarios in which two fourth-graders are debating, representing two competing theoretical positions regarding word learning (students also have the script for the scenarios to refer back to and follow along). Students were asked which student they agree with, along a 5-point Likert scale, with options being to strongly agree (or disagree) with a particular student, to somewhat agree (or disagree) with a particular student, or to agree or disagree equally with both students (see Appendix C). As in Part Two, students were asked to explain their rationale for each decision in an open-ended response. The competing positions in the questions contrast a more traditional view of word knowledge and learning (including equating word knowledge and learning with knowing or memorizing definitions) with a more complex, situated, sociocognitive view (such as learning words incrementally and experientially in a social context of use). High ratings on the assessment embody a theoretical orientation towards the complexity of word learning, and align with theoretical constructs found in the literature on vocabulary, situated cognition, and sociocognitive perspectives. This assessment helps to illuminate what theories of word learning students align with prior to and following the curriculum, whether they see these theories as context-specific, and whether they demonstrate metacognitive capabilities in applying various theories of word learning by evaluating when such theories are most effective, appropriate, or advantageous, and why.

Video of whole class discussions and small group work. Both implementations of the curriculum were videotaped from the first lesson through the last using two video cameras in year one and one video camera in year two, each recording with wireless digital microphones. A theoretical and practical rationale guided the sampling decisions and procedures for collecting videotaped data. Given the sociocognitive learning theory underlying the curriculum, and the critical role that collaborative inquiry plays as a context for learning, I sought to capture the instructional model and learning processes on video by sampling, (a) whole class discussions, (b) small groups working with the teacher while the teacher was circulating among groups to support their meeting the goals of collaborative inquiry, and (c) small groups working independently without the support of the teacher in pursuing goals of collaborative inquiry. This sampling strategy allowed for the potential to capture: (1) how ideas were introduced into discussions within the learning community, by the teacher and/or students, during whole class discussions and while working in small groups, (2) how ideas developed within the learning community, and (3) evidence of how students appropriated these ideas, putting them to use as tools for different purposes, in their discussions and inquiry projects.

In both years, all whole class discussions were videotaped. In year one, in addition to videotaping whole class discussions, two small groups were videotaped throughout their process of engaging in collaborative inquiry. The purpose of this sampling strategy was to capture the process a group undergoes while participating in the curriculum. One group was made up of boys and the other of girls, and each group included ELs. In year two, in order to understand more fully the pedagogical practices employed by the teacher while working with groups, the video followed the teacher as she circulated among and worked with different groups of students. In order to capture as many ideas as possible, the wireless microphone was taped to a stuffed animal and easily moved by the teacher or students, and from group to group, rather than worn by the same individual.

The Web of Inquiry. The Web of Inquiry software (Frederiksen et al., 2015) was used to help students develop a conceptual understanding of the process of scientific inquiry. The Web of Inquiry scaffolded students' inquiry process and learning, and the teachers made use of the dynamic resources embedded in the Web of Inquiry to support learning of aspects of the inquiry process.

The Web of Inquiry is a web-based platform that advances a model of learning science through reflective inquiry that integrates inquiry, metacognition, and self-assessment. It seeks to give students control over their learning, providing flexible and adjustable scaffolding in the form of advice and learning tools, and accounting for individual differences such as learning goals or advice preferences (Frederiksen et al., 2015). The process of inquiry is conceptualized in the 'Inquiry Cycle' and includes tasks and subtasks for students to complete for each step in the cycle, accompanied by prompts to guide students' thinking. In addition, for each task students are asked to rate their work in response to one or more questions using self-assessment rubrics mapped to the content of each particular task and which reflect goals for each. These rubric descriptors not only make the goals for tasks transparent for students, they embed assessment criteria into a formative self-assessment task that allows both students and their teachers to make use of higher-level criteria descriptors to prompt their thinking and reflection in order to improve their work.

In addition to the Inquiry Cycle tasks and subtasks, prompts, and self-assessment components, the Web of Inquiry also has tools embedded into the software that offer multiple forms of assistance. These include sample inquiry projects, a dictionary tool with synonyms and stories explaining words, sentence starters to prompt thinking for each task, questions to ask yourself, strategies to try, and a discussion tool (for reading and providing feedback to other groups). There is also a project report tool (which compiles the entire project into a report), a graphing tool (for organizing, displaying, and interpreting data), a blog (for conducting ongoing discussions and recording group ideas or questions), and a tool for searching the advice. Students' inquiry process is further scaffolded by the Web of Inquiry's "advisors," fictional characters built into the program who offer a variety of types of advice, guide students' decision-making about when to use advice to support their learning, and engage them in developing the various capabilities needed for collaborative inquiry and reflective learning. The Web of Inquiry also has a scoring tool for teachers to use in analytically evaluating inquiry projects in response to specific goals of inquiry and national science standards.

Data sources from the Web of Inquiry include student inquiry project reports, as well as digital video recordings of groups using the Web of Inquiry, and evidence documenting their early theories, and their more refined ‘Current Best Theories.’. These sources of data reveal students’ success in engaging in the various aspects and steps of the Inquiry Cycle, documenting students theories, their process of theory-evidence coordination, and the conceptual models they developed (see Appendix D for a sample Web of Inquiry group project report).

Vocabulary and science content assessments. The scientific vocabulary assessments developed for students to use in conducting their research reflect a theoretical orientation that word knowledge is complex and multidimensional. The assessments seek to incorporate multiple aspects of word knowledge so that the traditional measure of vocabulary knowledge, knowledge of definitions, is not applied as the single criterion for knowing a word. These assessments provide pre-post data for students as well as the researcher, and students used these data to measure the effectiveness of the different learning approaches they tested. Students grappled with the epistemological question of what it means to know a word and how such knowledge might be demonstrated when contributing to the assessment design, as a part of their inquiry process (see Figure 2 below for an example, and Appendix E).

As Bravo and Tilson argue (2006), words *are* concepts. Understanding the depth of students' knowledge of vocabulary words, particularly in science, requires a deeper understanding of students' understanding of concepts that words represent. To this end, vocabulary assessments collaboratively developed with students and used in this project hinge on the assessment of students' conceptual understanding of science concepts that scientific vocabulary words and terms represent. The Seeds of Science, Roots of Reading curriculum (Bravo & Tilson, 2006), provides a model for how to elicit students' conceptual knowledge of science concepts, using open-ended questions in which students demonstrate conceptual understanding by defining, drawing, labeling, inferring, questioning, reasoning and explaining.

3. Word: Adaptation

How would you define *Adaptation*?

____

____

Think of a situation involving the word as it is used in science. Draw a picture of *adaptation(s)* or use sentences to show everything you know about the meaning of this word (include examples and things connected or related to it):

Figure 2. Sample Item from Vocabulary and Science Content Assessment

In considering the amount of instructional time required by having students complete word-content assessments for each word both before and after applying each learning theory, and constraints on the time allotted for the curriculum itself, it was only feasible to ask two questions per word (asking for a definition and a more open-ended conceptual question). These two questions afforded opportunities for revealing that some learning theories that work well for one learning goal, such as knowing a definition, do not necessarily lead to a deeper understanding or knowledge of a word. Having students draw and label concepts in science offers students opportunities to visually display conceptual models and word knowledge, to characterize their word schemas, to demonstrate their understanding of relationships and mechanisms, and to show that they can picture a concept and things related to it, such as examples, without relying on language forms and scientific discourse practices. Open-ended questions also offered a more reliable opportunity to discover what students understood about science concepts without being prompted, and by emphasizing sketching and labeling as a technique, students' English language proficiency would be less likely to impede students' demonstrations of conceptual understanding.

Word knowledge rating guide self-assessments. Learning a word's meaning is an incremental process that occurs over time through multiple exposures (Stahl, 2003) occurring along a continuum that captures levels of word knowledge. Dale (1965) proposed four levels of word knowledge, ranging from "I never saw it before" to "I know it," while more recently, Paribakht and Wesche (1999) added a fifth level: "I can use it in a sentence." Taking this idea of rating one's own word knowledge, students completed a Word Knowledge Rating Guide as a pretest and posttest measure. The Word Knowledge Rating Guide includes the selected core vocabulary words, with one rating guide for each set of words and learning strategy. In the process of testing their three learning theories, students completed a Word Knowledge Rating Guide as both a pretest and posttest for each set of words aligned with three conceptual themes related to ecosystems.

Categories that comprised the levels of word knowledge in the Word Knowledge Rating Guide self-assessments were co-constructed with students. The teacher used questioning, prompting, and scaffolding practices to draw out aspects of word knowledge similar to those found in the Word Knowledge Rating Guides (Samway, 2007; Samway & Taylor, 2009) presented to teachers by Samway in The VINE Project Summer Institute, and found in the Seeds of Science, Roots of Reading curriculum (Bravo & Arya, 2007). While these sources provided a template to work from, the final levels and descriptors were created in collaboration with students as part of the inquiry curriculum. The teacher and students added dimensions to the scale that reflected the idea of schematic word knowledge, including ideas, concepts, and words related to the word in question (see Figure 3 below and Appendix F for examples). Like the vocabulary assessments, the Word Knowledge Rating Guide self-assessments served as data sources for both the researcher and the students. Students analyzed class averages and histograms showing growth in word learning for each of the learning approaches.

WORD	I've never seen or heard it before	I've seen or heard it, but I don't know what it means	I can use it, but I would have trouble giving a definition	I think I know what it means and can use it in an example	I know it and I can explain how it's related to other words and concepts
Ecosystem					
Community					
Adaptation					

Figure 3. Sample items from Word Knowledge Rating Guide

Structure of the Data Analyses

In this mixed-methods study, I employ both quantitative and qualitative analyses of data sources. I describe the purposes and sampling units for each below.

The Word Learning Theories Assessment. Quantitative and qualitative analyses of the results of the Word Learning Theories Assessment pretests and posttests were conducted. The sampling unit in these analyses is individual students from both the experimental and comparison classrooms. Analysis categories developed are applicable across multiple contexts in which the assessments are carried out, allowing for statistical comparisons of data across the two years of the intervention and between the intervention and comparison groups. These data and comparisons examine students' initial implicit word learning theories, as well as how their word learning theories and metacognitive capabilities for applying them changed following participation in the inquiry curriculum.

Classroom video and inquiry project reports. Analyses of classroom video and of students' inquiry project reports were also conducted. In these analyses, the sampling unit is student groups. The purpose of these analyses is to develop characterizations of the learning processes that occur. Video of whole class discussions and a sample of small groups, as well as the teacher working with small groups, provide illustrations of learning and instructional processes that led to changes in students' thinking that were revealed in analyses of the Word Learning Theories Assessment. Inquiry reports were also analyzed to identify and characterize processes students used in developing theories and metacognitive capabilities while participating in the curriculum.

Methods of Analysis

Analyses of the Word Learning Theories Assessment, classroom video, and students' inquiry projects entail a content analysis of qualitative data, which includes a "qualitative data reduction and sense-making effort that takes a volume of qualitative material and attempts to identify core consistencies and meanings," often identified as patterns or themes (Patton, 2002, p.453). This involves processes of "open coding" (Strauss & Corbin, 1998), which includes the development of emergent categories that are often thought of as inductive (or emic). Open coding in qualitative analysis is often used in early stages of developing a codebook for content analysis and for determining possible categories, patterns, and themes (Patton, 2002).

Qualitative analyses of the data sources also involves “selective coding” (Strauss & Corbin, 1998) of chosen categories determined prior to the analysis that are based on the intended purpose of the designed situation under analysis and theoretical considerations that motivated its design. These analyses are sometimes thought of as “deductive” (or etic). The process of coding for predetermined categories allows data to be analyzed according to an existing theoretical framework (Patton, 2002). These predetermined coding categories are supported by the theoretical framework guiding the study, and address each of the hypotheses for students’ learning outcomes that are goals for the curriculum. The combination of coding data using both predetermined theoretical constructs and emergent categories allows for the capturing of a range of responses, including categories which give consideration to specific context, as well as the more general learning situation afforded by the curriculum. While the learning theory and curriculum predict certain learning outcomes and broad categories to be coded (selective codes for theoretical constructs), the iterative process of moving from theory to evidence and back again is also used synergistically in creating reproducible emergent codes (open codes).

In analyzing the Word Learning Theories Assessment pretest and posttest for both the experimental and comparison classes, I coded data blindly with respect to the student, treatment, and time of year the assessment was administered. This allowed for the detection of patterns occurring within and across contexts that are not influenced by possible biases of the rater. In addition, multiple raters were trained and then asked to code a sample of the data in order to establish the reliability of coding. Having multiple raters code a sample of the assessments allowed me to establish the reliability and validity of the scoring for these data.

Analyses were conducted so as to allow for a comparison of results from each year, and to identify patterns across classes. Comparing coding categories across data sources allows for cross-validating findings for those categories. Coding for the presence or absence of emergent and predetermined categories also allows for conducting statistical analyses of qualitative data, such as finding frequencies of their occurrence, and how these vary across context, such as before and after the intervention and between the experimental and comparison classes. Qualitative dependent variables were analyzed using Generalized Linear Modeling for rating and count data, while quantitative dependent variables were analyzed using General Linear Modeling. In the following sections, I provide more detailed descriptions of methods of analyses for each of three data sources, (1) the Word Learning Theories Assessment, (2) classroom video, and (3) students' inquiry projects.

Methods for analyzing the Word Learning Theories Assessment. Separate analyses were conducted for each of the three parts of the Word Learning Theories Assessment, as each of the three sections include sets of qualitatively different types of items (open-ended questions, agree-disagree statements, and video scenarios). The analyses for the three parts of the Word Learning Theories Assessment include quantitative analyses of the two Likert-item sections, and qualitative analyses of the open-ended questions. This allows for results from each to be compared for consistency in patterns of responses and thus provide further evidence of the impact of the curriculum so that reliable interpretations may be made regarding its effect.

For both agree-disagree statements and video scenario items, which were in the form of justified Likert items, students selected the numerical response and wrote justifications giving the reason for their choice. The Likert item questions were phrased in such a way as to vary the directionality of a high-scoring response, so that it wasn't always "strongly agree" or "strongly disagree." For all Likert items, I first reflected the items to take this directionality into account to put them on the same scale (taking items for which a "1" was the high-rated answer and reflecting it by making it a "4"). However, when items included a double negative or required agreeing or disagreeing with a negative point of view, such as "you can't really figure out the meaning of a word you don't know from the rest of the sentence," students would sometimes be confused about how to understand the question and represent their beliefs. In order to be confident that the Likert item choices students made were indeed those they intended, I went through the entire dataset and identified any cases where students' written justified responses to questions *directly* and *explicitly* contradicted the Likert rating they chose. Because students in these cases wrote something that was contrary to what they circled, I assumed that these students had accidentally reversed the scale when they answered the question and I therefore used the scale value that was consistent with their written justifications.

I then trained a second rater and had them independently identify such instances to confirm my identification of cases for reversals; I did this by creating a spreadsheet with all of the original Likert scale and accompanying open-ended responses of cases I had already identified for reversals from year one (approximately 20 items). I then added the same number of responses for cases where I had judged there were no reversals, and randomized the order of the total 40 items. The degree of agreement of the rater's and my judgments was 90%. In all cases where the second rater disagreed, my judgment had been to accept students' original response while the other rater said to change them. In these cases, I accepted the students' original response. Thus, the second rater verified the reliability of reversals I made.

The agree-disagree statement and video scenario items from parts two and three were analyzed using a General Linear Model, while the qualitative analysis of open-ended questions from part one include a repeated measures analysis of variance for analyzing the overall number of theories students offered in response to the four open-ended questions. In all of these analyses, particular attention was given to whether results included any interaction with school year. This was important since if there was no interaction, it could be concluded that the second year's treatment was a replication, and the data for both years could be analyzed as one data set, increasing the power of the model and the sample size, which was particularly important for analyzing performance of ELs. Data from both years were combined for correlational analyses of patterns. Class comparisons were carried out by introducing year as an independent variable for identifying variation and consistency in patterns of responses. When I found that there was no difference in responses between the two years (no interaction), I conducted a similar ANOVA using language proficiency (EL versus English Proficient) as a variable in place of year. I also used a General Linear Model to analyze the data of ELs in particular, and compared their performance to that of English Proficient (EP) students for both experimental and comparison groups.

Further qualitative analyses of responses to the open-ended questions in part one include McNemar Exact Significance tests (2-sided) of prominent emergent and predetermined theories and coding categories of students' responses to the individual items, comparing the experimental and comparison classes, and analysis of patterns of theories offered by English Learners. In the case of predetermined constructs, I created a codebook of the codes that aligned with each theoretical construct I hypothesized would be evidenced in student responses before coding. Then I coded student responses to the four open-ended questions for evidence of these theoretical constructs.

For detecting emergent patterns in students' theories, I created an emergent code for each discrete theory, idea, mechanism, or model present in a response that explained or predicted the phenomenon in question. Based upon the students' words, I created and expanded each coding category with examples. In order for an idea or theory to be coded for a certain category, a student must have explicitly stated the idea represented in the coding category; if ideas were related to a coding category but required interpretation or extrapolation to make those connections, then it was not coded for the given category. After generating a broad number of fine-grained codes representing all of the students' responses for a question, I looked for overlapping categories and, where appropriate, collapsed categories that represented the same idea to create composite variables.

Six outside raters were trained in the coding system and coded a sample of the same data in order to establish interrater reliability and validate the coding scheme and scores. Raters were blind to students' condition (experimental or comparison), the time of year the response was given (pretest or posttest), as well as students' gender and language status. Each rater scored a sample of student responses to one of the four open-ended questions from the Word Learning Theories assessment. Questions one and four were each scored by an individual rater, while question two had three raters and question three had two raters. The raters scoring questions one, three, and four scored 30% of the total sample of responses for their questions, while the raters for question two scored the entire sample from the first year data set. This way, a representative sample was scored for each question, but one question was scored for the entire year one dataset by multiple raters.

Raters coded each response for the presence or absence of the multiple emergent and predetermined codes. Reliabilities calculated include the percent of coding categories for which there was exact agreement between the rater and the researcher. The average percentage of exact agreement in scoring across all questions and raters was 89.2%, with exact agreement by rater and question being 86.5% for the first rater (for question one), 91.1% for the second rater (for question two), 88.3% for the third rater (for question three), and 90.8% for the fourth rater (for question four). These reliabilities serve to validate the scores attributed by the researcher and demonstrate that the coding process is replicable. The high percentage of exact agreement likely reflects the emergent nature of many of the coding categories, with the codes themselves being fine-grained, explicit and specific to student responses as they came from those responses. See Appendix G for a list of emergent and predetermined codes for how people learn new words (question 3).

Finally, in addition to coding for emergent and predetermined categories, I also coded each of the four open-ended questions for the total number of theories a student offered in response to each question. I counted each discretely different idea unit students offered in response to a question as a theory for predicting or explaining a response to the question. This meant that a student could offer one or more ideas within a single sentence, so long as they were discretely different ideas. Ideas that were rephrased or repeated in a different way were not coded as separate theories. Furthermore, a student may also have responded to the question but not provided an appropriate idea, if for instance they misunderstood the question. In such cases, a written response might be coded as having no theories present.

Methods for creating and analyzing the classroom video database. Video sources of data available for analysis reflect the sampling principles used to guide data collection described earlier, and include video of whole class instruction for both years, video following the same two small groups of students working independently and with the teacher for year one, and video of a variety of small groups working with the teacher in year two. With the pedagogical model of conducting inquiry on a shared topic as a whole class, video of whole class discussion is particularly relevant for analysis. The work done in this setting included students' collaborative introduction and development of theories and ideas, with whole class discussions serving as a kind of scaffolding for students when they shifted to working in groups.

The methods for analyzing video discussions were informed by the notion of characterizing and understanding how ideas are seeded into, migrate among, and become appropriated by members of a learning community (Brown & Campione, 1996). I used the metaphor and framework of seeding, migrating, and appropriating of ideas as part of a dialogic base operating within a community of learners (Campione, Shapiro & Brown, 1995) to guide my thinking about how to analyze how ideas develop within the learning community. Given my interest in how ideas develop collaboratively, in my analysis, ideas were not regarded as static—introduced by one person, traveling, or taken up unchanged by other individuals in the learning community. Instead, I looked at the genesis of ideas and how ideas first originated—or were *introduced*—within the learning community, and sought to understand the context and processes involved in how they are introduced and by whom. Since I was paying particular attention to the history and process of the development of ideas, I looked at how ideas, once introduced, took shape within the learning community over time, which included understanding processes by which students *pursued an idea* to see its relevance or usefulness within their theory-building and inquiry research. Finally, I looked for evidence of how members of the learning community appropriated or *adopted* these ideas and *put them to use in other situations*, using the idea as a tool for multiple purposes, such as for predicting or explaining things, and ways they made use of the idea as learners in their own lives.

The video analysis includes a focus on the ways questions, ways of thinking, ideas, and a language of practice originated and developed in the context of whole class discussions. Students showed further evidence of ways in which they appropriated such big ideas in the collaborative work, interactions, and discussions which took place in their smaller research group, both with and without the teacher present.

In order to address the research question 'How does the instructional environment foster the development of students' metacognitive capabilities?' I analyzed video of students engaging in the curriculum from both years. I began by creating a video log of all video, keeping a record for each video of the date, year, tape number, the inquiry step within the curriculum, and the topics being discussed. I also made notes for each video, including information such as sound and video quality. Finally, for each video, I created annotations that included some transcription and near-transcriptions. The sample included a total of 42 days of video (17 days of video in year one, 25 days of video in year two).

Defining the unit of analysis and delineating conversational units. In preparing to analyze video for the process of collaborative development of ideas, I defined the unit of analysis as occasions in which participants discussed their thoughts and ideas about how people learn words. This unit of analysis, following Strauss and Corbin's (1998) theoretical sampling method, served as a top-level filter for identifying and coding instances of discourse relevant for addressing the research questions. Applying this unit allowed for pinpointing discussions where students' theories and metacognitive capabilities developed so processes within these situations could be further analyzed. This unit of analysis differentiates between *theory-related discourse* and *other discourse* that could be conceived of as "noise" for the purposes of this investigation (off-task talk or talk unrelated to curricular goals and tasks, such as talk about what is for lunch, whose turn it is to type, etc.).

After applying the unit of analysis to differentiate between theory-related and other discourse, I then applied open and selective coding strategies (Strauss & Corbin, 1998) to delineate *topical conversational units* around the development of theories or ideas about learning words. Units were identified as beginning when a new idea related to a topic was brought up for discussion and pursued, and ending when a new idea was introduced that superseded the previous idea, initiating a new topic for discussion. In parsing classroom discourse into these conversational units, my sampling principle was to first locate all segments in the video where ideas about how people learn words were contributed to a conversation, whether by a student or by the teacher, in both whole class and small group contexts. Each segment of a new idea relating to how people learn words that emerged served as a unit in the video database. This coding scheme allowed for analyses to illuminate how conversational topics pertaining to processes for learning words were traced, followed, and then dropped as new topics were taken up, revealing the life of an idea or topic as topics of conversation changed according to the ideas for learning words that were discussed. This process also allowed for frequencies of ideas to be discovered, as well as for the construction of standards for characterizing and describing how the collaborative community of learners built ideas together, listened and responded to one another, and bounced ideas off each other as they synergistically constructed an evolution of ideas. Furthermore, defining content-based units based on conversational threads around a topic allowed for an analysis of the development of whole, coherent arguments, in which ideas were introduced, clarified, collaboratively constructed, evaluated, and coordinated with evidence.

As I defined units from the total sample of video, I created a video library of units in the form of a database that included all of the information for each unit from the video log, in addition to participant structure (whole class, small group with teacher, small group without teacher), a short description of the unit topic, and a video clip of each unit. After identifying 161 appropriate segments, I reviewed the units for accuracy, and further focused on discussions distinctly related to word learning (and situations where the recordings captured audible discourse). The final database included 145 video discussion units with 46 units from year one (all from a whole-class setting), and 99 units from year two (with 59 from a whole-class setting, 34 of small groups working with the teacher, and 6 of small groups working without the teacher).

Levels of analysis of video units. I conducted two levels of analysis of video discussion units. The first analysis was of the full corpus of video in the database (all 145 video analysis units), with the aim of depicting and characterizing the ideas developed over the course of the curriculum. My purpose was to understand if and to what degree ideas showing change in pre-post data were developed in discussions. The second video analysis is a subsidiary analysis of eight video units that contained enough information to allow for a more detailed examination of important processes and practices that fostered the collaborative development of ideas in the context of the curricular environment. The analysis of the sample of eight exemplar units also revealed processes that are important in the collaborative development of ideas over time. After analyzing the eight video exemplars and detecting recurring patterns in processes contributing to the collaborative development of ideas in the learning community, I chose a subset of five video exemplars to include in the results section (see Appendix H for the other three).

Methods for selecting video exemplars for further qualitative analysis. To select the subset of video discussion units for the subsidiary analysis, I employed a process of purposeful sampling, beginning with an analysis of the coding categories used in coding the entire video corpus. These included categories from both the Word Learning Theories Assessment analysis, as well as emergent categories. I first identified categories that directly coded for students metacognitive capabilities, and then looked for categories that entailed students' demonstration of metacognition or ways of thinking and talking about how they learn. Of the 116 categories used in coding the whole video data set, I found 21 categories that either coded directly for students' metacognitive capabilities (such as identifying learning goals and problem-solving strategies, and reflecting on one's own word knowledge and metalinguistic features of words, etc.), or which were likely categories for students to demonstrate such capabilities (such as presenting a sociocognitive view of learning). These 21 categories are found in Table 2 below, and are organized around the four open-ended questions from the Word Learning Theories Assessment (Why do people learn new words?, When do people need to learn new words?, How do people learn new words?, and What does it mean to know a word?). After ruling out units that were not coded as having at least one of the 21 categories identified, the corpus of video data was reduced only minimally, with 133 units coded as having one or more of the 21 categories.

TABLE 2
Video Coding Categories Revealing Metacognitive Capabilities

Why do people learn new words? • Seeing purpose for learning, identifying learning goals • To become a better learner, self-efficacy
When do people need to learn new words? • In anticipation of a specific situation • Learning across two languages • Multiple situations for learning, goal driven need for word learning
How do people learn new words? • Multiple strategies for learning words • Sociocognitive learning theory • Strategic in applying learning theories • Problem solving strategies for resolving unknown words • Word consciousness and awareness of how we learn words • Text considerations (types, difficulty) • Learning across languages (family, friends, traveling, cognates) • Developing self-efficacy, seeing uses of theories, how to apply them to improve as learners • Developing metalinguistic knowledge
What does it mean to know a word? • Picturing a word and what it's related to • Word schematic knowledge • Knowing for a given purpose, different ways to show you know words • Sociocognitive, in context of use • Metalinguistic features of words • More than rote memorization • Reflecting on own word knowledge

Recoding video to narrow in on exemplar units: Fostering students as theorists, critics, and expert learners. After narrowing down to include only the 21 metacognitive coding categories as the first sampling criterion, I next recoded the 133 video units around three themes which were central to the goals of the curriculum and which emerged as prominent principles from the first round of video data analysis. These were opportunities in which students acted as *theorists,* as *critics,* and as *expert learners*. I used open coding for emergent categories under each of the three themes, finding eleven categories for students as theorists and for students as critics, and fifteen categories for students as expert learners.

Choosing a smaller sample of extended discourse for detailed analysis. In order to further reduce the data, I employed purposeful sampling to identify units with the greatest affordance for students to demonstrate their use of metacognitive capabilities. Within the theme of students as expert learners, I selected units coded for the emergent category of reflecting on how to improve one's own learning process or oneself as a learner (with 32 units), I narrowed this selection down to units from year two in order to preserve the possibility of analyzing both whole class and small group discussions. Since students' conversations took place over time while participating in a sequence of tasks aligned with the Inquiry Cycle, I sampled for units across the Inquiry Cycle steps. This was also intended to capture how the different aspects of inquiry students attended to—and the goals of each—guided their thinking about their theories and metacognitive capabilities for applying them over time. Students' thinking about theories for learning words and metacognitive capabilities for applying them interacts with the step of the inquiry cycle they engaged in, including brainstorming many theories in the beginning, becoming more precise about their theories while designing an investigation to test their theories, and focusing in on one theory while analyzing their data and coordinating their theory with evidence in coming up with a 'Current Best Theory.' In the final stages of their inquiry, they refined their theories while considering alternative theories, mechanisms, or processes that could also explain their results, and various uses of their theory for themselves as learners as well as for others in the world, such as other students, teachers, and even school board members.

From the remaining units, I selected units which were also coded for other categories central to curricular learning goals, including (1) demonstrating word consciousness and word awareness in learning, (2) being flexible or strategic in using learning strategies to help meet different learning goals, (3) advocating the use of multiple strategies together, (4) advocating the use of word learning strategies in a particular order, and (5) recognizing that word learning strategies may be applied strategically for studying or doing well on tests. Eight video discussion units comprised the final sample for the more fine-grained analysis of discourse and teaching practices and processes. Of these, all were coded for the category of students reflecting on how to improve their own learning process or themselves as learners, while seven were also coded for students being flexible or strategic in using learning strategies to help meet different learning goals. Six were coded for students advocating the use of multiple strategies used together, and four for the use of multiple strategies in a particular order. Finally, two of the eight units were coded for the idea that word-learning strategies may be applied strategically for studying, and for students demonstrating word consciousness or word awareness in learning. While steps of the Inquiry Cycle might overlap in discussions, these units sampled across the steps of the Inquiry Cycle, and included two from Questioning and Theorizing, three from Analyzing Our Data, and three from Synthesizing. The five video exemplars included in the results adhere to this sampling principle, and represent each of these steps. Exemplars found in Appendix H include those of whole class discussions, as well as those of small groups working with and without the teacher.

Methods for analyzing students' Web of Inquiry project reports. Students' initial theories and Current Best Theory offered in their small groups and recorded in their Web of Inquiry project reports were analyzed for evidence of students' developing metacognitive awareness and capabilities. A content analysis of the Web of Inquiry project reports was conducted with a focus on particular sections and steps in the inquiry process which offer students greater affordances for articulating and reflecting on their learning theories. These include the Web of Inquiry project report sections *Our Theories*, *Our Current Best Theory*, *Explanation for Our Theory*, and *Further Research*. This analysis of project reports also offers another source of process data, and one to which all students contributed in their groups, while video analysis was limited to the students that appeared in the video. These data sources and their analyses help to further understand findings from the Word Learning Theories Assessment and video analyses. This presents an opportunity for characterizing students' theory-building in the context of the curriculum, as well as for analyzing ideas specific to the members of each group, complimenting the video data sources that reveal students' theory-building in whole class discussions and in the sample of small groups videotaped. The predetermined coding categories applied in analyzing the students' Web of Inquiry project reports are informed by patterns and findings from the video analysis, and help to corroborate those findings. These include looking at and understanding whether students offered or explicitly advocated using multiple theories and accompanying strategies for learning words, whether their theories demonstrated flexible, strategic use of learning strategies in order to meet a variety of goals or situations, whether students offered an explanation or evidence for their theory, whether they framed their theory as an argument, trying to persuade or convince others of a position, or in drawing a conclusion, and whether their further research advocated the investigation of theories which suggest the flexible or strategic use of theories and strategies tested in their inquiry research.

Results

The focus of this study's analysis is on the development and refinement of students' theories of word learning and their metacognitive capabilities in using and applying their theories while learning scientific vocabulary. I begin by describing the curricular activities students participated in, to provide a greater understanding of the context and students' experiences with the curriculum. I follow this description by reporting results of several analyses, each one addressing and guided by research questions of the study. In the first of these analyses I examine whether the curriculum contributed to changes in students' thinking and metacognitive capabilities. Following that, I present results of analyses in which I characterize learning processes and teaching practices fostering such changes.

My first analysis provides a description of students' engagement within the learning environment. The purpose of this is to present the curriculum and what students experienced while engaged in it, in order to characterize what students actually did while participating. This provides an important foundation for understanding the type of collaborative inquiry students conducted, and how these experiences contributed to changes in their thinking and capabilities identified in subsequent analyses.

The second analysis is an examination of the impact of the curricular experience on changes in students' word learning theories and metacognitive capabilities for applying them shown in the Word Learning Theories Assessment. This consists of a detailed analysis of the Word Learning Theories Assessment, as it captures students' initial theories and how they may have changed over time. Results of the analysis of the Word Learning Theories Assessment address the first research question, *Does a collaborative learning environment in which students form and test their theories for learning new words in science facilitate the development of students' metacognitive capabilities?* Because the Word Learning Theories Assessment is available for the comparison classes for both years that the experimental curriculum was introduced, the analysis of these data allows me to determine whether the curricular approach contributed to students' developing theories and metacognitive capabilities, and in what ways. Furthermore, such analyses provide evidence of whether students' theories became more coherent and integrated over the course of their participation in the curriculum. It also reveals students' growing awareness of their own learning processes, their increasing capabilities in managing learning strategies, and ways they consider putting their learning theories to use in their lives. The analysis also allows a comparison with the other classes in the same school who had the traditional science curriculum.

In my third analysis, I present results from analyses of video of classroom discourse captured in the two years of the study in order to address the second research question, *How does such an instructional environment foster the development of these metacognitive capabilities?* I begin by presenting results of an examination of the ideas and theories that students developed through collaborative discourse over time in the context of conducting inquiry into their own theories of how they learn scientific vocabulary. I also present results of an analysis of a small number of videotaped discussions that were sampled from the entire video library. Of eight exemplars analyzed, five are presented here to demonstrate processes which foster students' metacognitive development (three more are found in Appendix I). These exemplars show the types of discourse practices and processes underlying the collaborative development of ideas pertaining to students' developing metacognitive awareness and capabilities. In addition, types of teaching practices that foster students' development of these ideas and capabilities are also revealed. Together, analyses of the collaborative discussions from the exemplars sampled illuminate how ideas develop over time and ways in which the learning environment fostered students' developing metacognitive capabilities.

I conclude the results section with an analysis of students' Web of Inquiry Project Reports. This analysis entails an examination of students' theories and how they develop over time, focusing on ways students demonstrate metacognitive capabilities. While much work and thinking was accomplished in a whole class setting, students in small groups of 2-3 worked collaboratively to come up with their own particular theories and hypotheses to test within the context of the investigation. Students in their research groups documented their thinking throughout the entire inquiry process in their Web of Inquiry project reports. These reports serve as another data source for analyzing the development of ideas in groups over time..

I. Description of Students' Engagement with the Learning Environment

Generating theories. In anticipating theories students would potentially have about how, when, and why people learn words, in designing the curriculum, I considered ways to prompt students' thinking about word learning that might contrast with a more traditional, "old-school," or mainstream view of vocabulary and word learning (such as using abstract dictionary definitions and exemplary sentences), with a more situated, sociocognitive, and metacognitive perspective of word learning. Recognizing that a critical aspect of the curriculum was to frame the inquiry around investigating students' own theories of word learning, I began the unit by eliciting students' ideas about what it means to know a word, how people know when they know a word, why people need to learn words, situations in which people need to learn new words, and how people learn new words. As a whole class, students began by brainstorming ideas in response to the same four questions from the Word Learning Theories Assessment, creating class charts of their collective responses. Students were already familiar with these questions from having completed the Word Learning Theories Assessment pretest.

A goal in designing the curriculum was to scaffold students' process of generating word learning theories, with students coming up with their own theories to investigate, but also so that their theories (and investigations) would reflect and test a sociocognitive and sociocultural view of learning words. After the initial brainstorm, I presented students with a scenario in the form of a story in which a child learns new words, which was suggestive of a sociocognitive theory of learning aligning with theories of situated cognition and legitimate peripheral participation. Students then generated theories for how the child in the story learned new words (see Appendix I for curricular plan):

> A girl went out of town to visit her family who owned a farm, and stayed on the farm for a few weeks. At first she listened to her family discuss the operations of the farm using technical words that she didn't understand and which she had never heard before. Over the course of her visit, she listened and watched as her family members used these words while performing the jobs and tasks on the farm, and the girl also learned about how to perform some of the jobs, first by observing, listening, and then finally assisting her family members. By the end of the trip, she realized not only did she learn a lot about farming, but that many of the words that she didn't understand before she now understood in the context of the daily operations and conversations that everyone was having while working together to run the

> farm; she realized that she herself now used those very words that just a few weeks before were unfamiliar.

After presenting the scenario, the students were asked how they thought the girl learned all the new words, what was important, helpful, or useful for her in learning the words, and what might be most helpful for anyone learning a set of new words.

Another teacher and I had generated all of the possible responses we could think of to the same four questions in advance of the lesson, and I was prepared to use the lists to prompt students' thinking of ideas that they hadn't volunteered on their own. I was excited to find that in response to every question, the students collectively identified every idea that my colleague and I had come up with, and then some. Furthermore, their initial theories—in response to the questions I posed, and follow-up probing questions scaffolding the class brainstorm— reflected a sociocognitive and situated perspective. While it was my aim to scaffold their arriving at sociocognitive theories for learning words by prompting their thinking in response to scenarios like the one above, I found this wasn't a stretch for them by any means. The students were also excited to hear my list of possible responses to the questions and compare it to their class charts, especially to find that all of our ideas, although sometimes worded differently, were represented in their ideas. Examples of theories students generated in the first brainstorm session may be found in Table 3 below:

TABLE 3
Theories of Word Learning – Class Brainstorm Charts

Why do people learn new words?	When do people learn new words?	How do people learn new word?	What does it mean to know a word?
• Using words, downtown, reading signs • To communicate, to be part of a conversation, with parents, teachers • To learn at school, improve writing, problem-solving • To understand something • To become part of a community, at home, in clubs, in the world • To match an idea with a word • To study for a test, to understand what the question asks, to do well • To pass time, for fun • For some health reason, like if you break a bone • For a job, teaching, construction, architecture, accountant, stylist, doctor • Going different places, to describe experiences	• Reading • Watching TV • Radio • Conversations, with friends, family, teachers • School • Museums, field trips • Soccer games, sports, clubs • Learning a new language • As infants, learning to talk, learning a new skill • On the job • Homework • On the bus, out in the world • Playing an instrument • Tutorials, lessons • Doctors office, legalese	• Go to a museum, go on a field trip, different places • Glossary, dictionary • Computer • Ask someone what it means • Ask to go to places where you can discover new words • Study words, look at it and the definition • See how its used in a sentence • Reading, look for words in context • See how its connected to other words	• Definition • Meaning • Are able to use it, in a sentence, write it, say it • Can visualize it • Sometimes you have to experience it to know it • See how it's connected to the things related to it (like a carnival, with games, music, food, smells, sounds) • Different kinds, can know how to pronounce it, know the meaning of it, you can get to know it better

Epistemological understanding of word knowledge. Bruer's analysis of the theory of associative structure and cognitive architecture (Bruer, 2000), as well as Nagy and Scott's research on word schemas (Nagy & Scott, 1990), provide a provocative framework for thinking about and guiding instruction in word learning, and particularly for engaging students in epistemological inquiry around notions of what it means to know a word. Importing this notion into instruction and prompting students to become aware of their own schematic knowledge and associative networks related to words, and building on prior knowledge as a way to integrate new knowledge into preexisting schemas in order to learn new words, informed the curricular approach. In additional brainstorm sessions, students further explored ideas about what it means to know a word by considering how one can show that one knows a word, and what one would do if one were trying to teach someone some new words/concepts. Students' ideas in response to these questions are summarized in Table 4 below:

TABLE 4
Theories of Word Knowledge – Class Brainstorm Charts

How can we show that we know a word?	If you were trying to teach someone some new words/concepts, what would you do?
• Take a test • Use the word in a sentence • Share the definition/meaning • Visualize the word, sketch/draw the word and what it's related to • Write a story with it • By working in groups	• Reading, learning in context • Learn from others, share experiences • Use flashcards, study for a test • Use a glossary • Research online, use the library • Ask people • Go to a special place where you could see something in action, arboretum, aquarium

Following this exercise, the students as a whole class co-constructed a rubric or way of measuring and assessing how well one knows a word according to the group's conception of what it means to know a word. As the teacher, I scaffolded this process by prompting students to reflect on multiple aspects of their own word knowledge, and especially to recognize and identify other types of word knowledge in addition to definitions. Together the class constructed a typology of word knowledge consistent with the continuum represented in the Word Knowledge Rating Guide described earlier (see Appendix F). Some of the students' ideas for the highest level of knowing a word included “to think of the word and say the things that surround it,” “to give a synonym,” “to draw a picture of the meaning of the word and things related to it,” and to ask yourself the question “Can I visualize it and the things that surround it that its connected to?” As the teacher, I chose words as examples to demonstrate to students how it was possible to think you know a word, but to be at a loss when asked to define it (a task I demonstrated as being challenging and requiring thought on the spot!). In their continuum and co-constructed rubric, students recognized that it is indeed possible to be able to use a word correctly and give examples without being able to give a definition. The students’ final highest-end descriptor for knowing a word which they used in their co-constructed rubric and Word Knowledge Rating Guide was being able to understand the word in context and seeing its connections to other concepts, while lower ratings were being able to recognize a word without knowing what it means or being able to use it or give examples.

Designing the investigation. After generating theories for learning words, students were presented with the specific learning goal of investigating the best ways for learning new words in science. They were also presented with a rationale for choosing science as a content area for their inquiry, which included that science has many infrequent words and words that represent specialized content knowledge, and that the state has identified specific content standards students in fourth grade must learn in science. Therefore, the question posed to students, which would frame their investigation, was “what are theories for how to best learn words (and their concepts) in science?” The students then decided on three learning strategies to test as a whole class which reflected their most popular theories and which were feasible to test given the parameters and constraints of school. These were: (1) reading the words in context; (2) using a dictionary to identify definitions and to make flashcards to study them; and (3) going on a field trip to an area where you could learn words by “seeing and experiencing them in action” with the help of a more knowledgeable other (a teacher or a naturalist) who could explain them and point them out to students.

Students first deliberated about their research design as a whole class, agreeing that it would be best for the whole class to test the same three strategies, since if each small group of 2-3 students were to choose a different strategy to investigate, it would either take too much time for the whole class to test each or, if only one group were to test each strategy, the sample size of 2-3 students would be too small to be reliable. Finally, they also recognized that if participants in small groups each tested one strategy, it would be problematic comparing the results, which could be explained by differences in students’ prior knowledge or learning styles. In addition to the advantage of having data from each student, students were motivated to be able to see which of the three strategies would be most useful for themselves.

Students grappled with aspects of research design as any researcher would. They developed assessment tools for capturing growth in word knowledge, creating and revising the rubric which was used in the Word Knowledge Rating Guide self-assessment pretest and posttest, and which was also used to score the vocabulary word-science content assessments. They also decided on a rationale for choosing particular types of words to learn, and emphasized the need for comparable sets of words to be used in each trial, so that the words weren't disproportionately easy, challenging, or already known by a number of students for a particular trial. Students also debated how long to spend on any one strategy, deciding each trial would last 25 minutes, since students would also need to take pretests and posttests the same day.

Another question students considered as a class, was how many words they should attempt to learn while using each strategy. Since each word would increase the amount of pretest and posttest time required, thus reducing the time spent using the strategy, students wanted to choose the smallest number they could. They wanted a large enough set to increase the likelihood that the words might be new to students. They didn't want to have too many words since the words would be specific to the science content area and conceptually complex. Students were concerned that if there were too few words, they might all learn all the words using each strategy. Students decided eight words seemed enough for these potential problems to be less likely.

Finally, in order to reduce potential variance in the data due to factors related to what words were chosen, the class decided on using a randomized block design. This could have been achieved either by having a third of the class each using a different strategy with the same set of words on the same day, or using the same strategy but different sets of words on the same day. The latter was decided upon since it was not possible for only part of the class to go on a field trip.

After making decisions about the research design as a whole class, students began to work in small groups using the Web of Inquiry, beginning by theorizing about how best to learn words in science with regard to the three chosen learning strategies. Groups identified independent and dependent variables, possible research questions, and finally chose a specific research question. Students in their groups also came up with alternative hypotheses, and provided a rationale for why someone might find each believable. An example of one group's theories is shown in Figure 4 below (see Appendix D for a full Web of Inquiry group project).

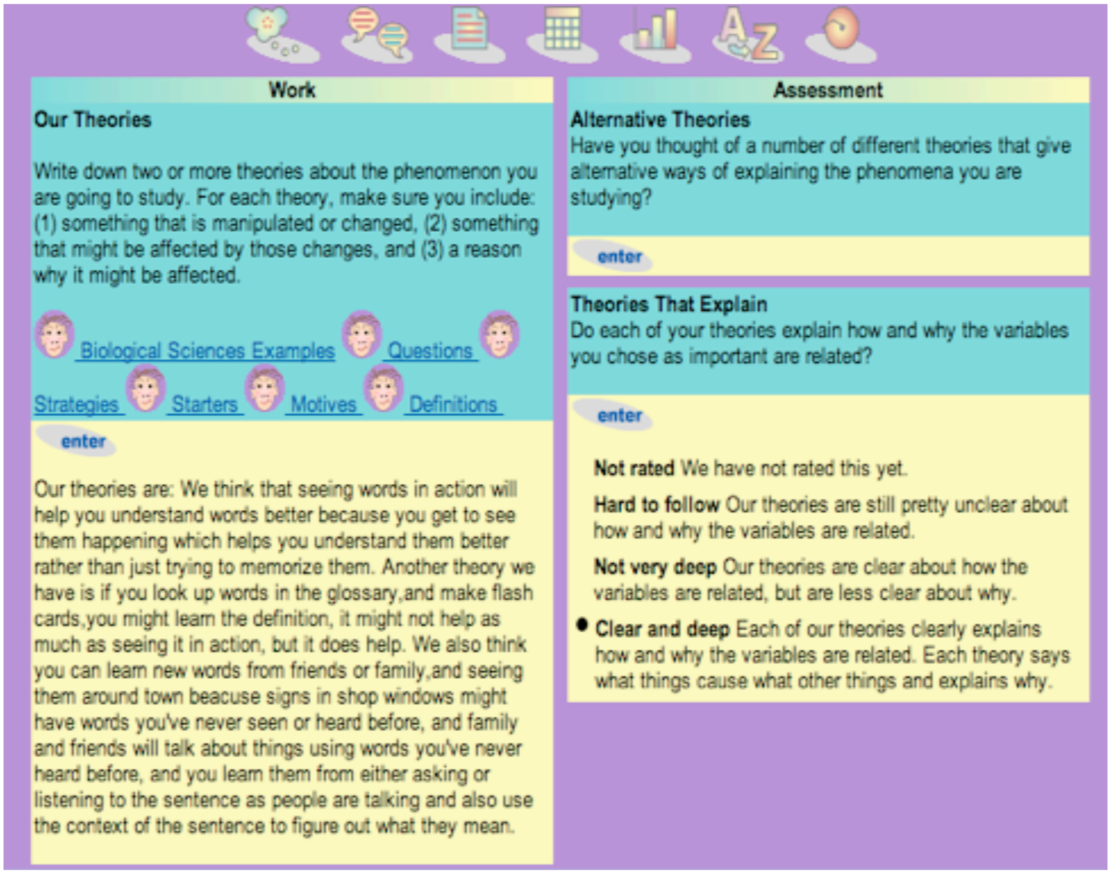


Figure 4. Questioning and Theorizing in the Web of Inquiry: Our Theories

Although the whole class chose three learning strategies to test, the theories, research questions, and hypotheses students generated in their groups varied. For instance, one group predicted using a dictionary to look up words and make flash cards would be most effective with an explanation for why, while another group argued for why reading would be most effective. Investigating a shared topic and set of strategies at the class level, allowing the whole class to discuss topics such as research design, data collection, and data analysis, helped build a sense of community. Meanwhile, students were also able to investigate or advance theories and ideas within their group, as even groups who agreed on the effectiveness of the same strategy often articulated different reasons for why that would be.

Data collection, analysis, and future research. Although students were not asked to describe their individual experiences using the three learning strategies as part of their inquiry, they did score each of the strategies on a five-point scale for how helpful or useful they felt each was. In addition, they reflected on and made observations of their experiences using each strategy as they completed the step in the Web of Inquiry for reporting problems they encountered during their investigation. While students recognized the unavoidable limitation of having only one trial for each learning strategy (necessary due to time constraints), for the most part, they described more problems with the flash card and reading strategies than for the field trip.

For the flash card strategy, students noticed it took a long time to make flashcards, with some students spending most of their time looking for words in the dictionary rather than studying them. Many students also had difficulty finding words in the dictionary, especially when a word was found under a word with a different part of speech, like for the word 'interdependence', which was found under the word 'interdependent.' Students also had trouble using guidewords to find their word, and finding definitions of polysemous words, which required them to distinguish the appropriate scientific definition. Finally, some students perceived these problems as a result of not having had enough time to test the strategy. For the reading strategy, students were given selections from two California science textbooks that contained the core vocabulary words. Some of the problems students described included the text was not comprehensible to everyone in their group, and that even when students were able to decode the text, it wasn't easy to understand.

For the field trip strategy, students seemed to really enjoy themselves when they went as a class to a nearby wetland. The students were in three groups based on the words they were assigned to study according to the block design. The teacher-researcher (a former naturalist and outdoor educator) accompanied one group; the classroom teacher (with a B.A. in marine biology and a supplementary teaching credential in life science) accompanied another group. A Spanish-English bilingual Title I reading teacher with over 30 years of teaching experience and a parent volunteer accompanied a third group. In these groups, the adults and students together looked for evidence of the words in action within the natural environment. Some examples of seeing a word in action included seeing a group of grebes swimming close to shore and hiding in the tall tule reeds, and pointing this out as an example of the word 'shelter,' or examining pussy willow catkins releasing pollen from a willow tree, as an example of the words/terms 'seed dispersal' and 'pollination.' Students used strainers to find aquatic organisms in the freshwater lagoon, and placed organisms in a bucket to study more closely. They saw stonefly and dragonfly nymphs eating smaller insects, and used this as an example of seeing the vocabulary word 'predator' in action. Problems encountered with this strategy included finding examples of all of the words in nature, and that some students, who were excited about being in nature and looking for things, might not have listened attentively to the adult or student when they were sharing each example. Finally, students noted in the Web of Inquiry section ‘Problems With Our Data’ that the class seemed to be less motivated to do their best work completing the pretests and posttests by the third trial because they were getting tired of taking the tests. Examples of problems encountered by two different groups summarized in their Web of Inquiry notebook are below:

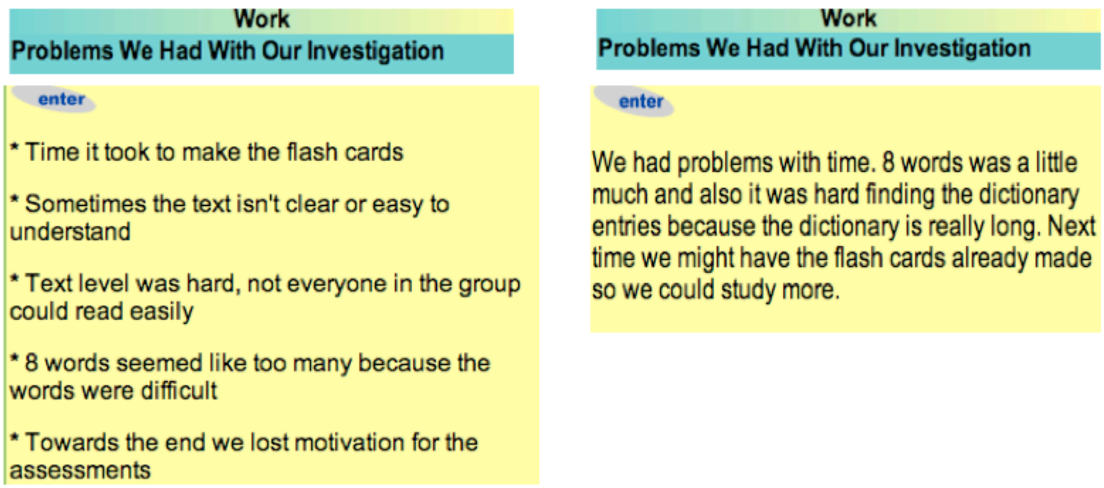
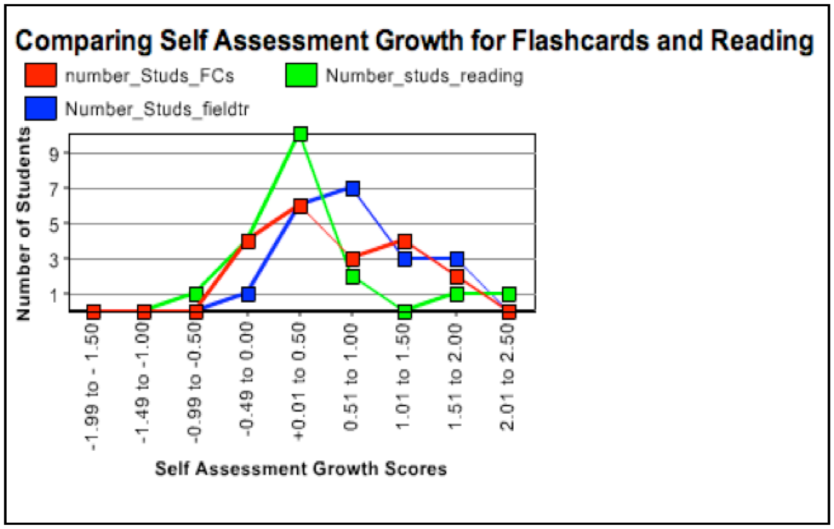


Figure 5. Reflecting on problems with the investigation in the Web of Inquiry

After reflecting on their investigation process, students summarized and began to analyze and find patterns in their data. In order for students to compare the results from the three learning strategies, the researcher scored students’ vocabulary word and science content assessments. It had previously been decided that the teacher would do so since it would be a lot of work and time for students to score their own or each other’s assessments, and it would also be difficult for students to score assessments for words they didn't know or that were new to them. The same rubric students co-created as a whole class for the Word Knowledge Rating Guide was used as the rubric for scoring the vocabulary word-science content assessments.

Once their assessments were scored, the students calculated their individual average scores for both the vocabulary word-science content assessments and the Word Knowledge Rating Guides (pre and post) for each strategy, and then found the class average for each. Students then calculated a mean difference score from pretest to posttest, and recorded their mean difference scores for both the vocabulary-content assessments and the self-assessment on post-it notes and used these to create histograms for each strategy and assessment. These were later entered into the Web of Inquiry with the graphing tool, enabling students to create different types of graphs to help them notice patterns in their data, such as peaks, amount of spread, and bimodal distributions. The sample histograms below are captured from different students' research group projects, and appear just as the students created them, including the headings, keys, and colors students used, (Field trip = FT, fieldtr; Flashcards = FCs; and Reading = reading). The X-axis shows students' average growth in word learning along the five-point scale of the Word Knowledge Rating Guide rubric, while the Y-axis shows the number of students in the class making that amount of growth. In both examples, the results of all three strategies are shown on the same graph with a key by color, allowing students to make comparisons. While results of all three strategies are represented on each graph, headings reflect the research question and hypotheses of the group. The first graph reflects a research question comparing flash cards with reading for students' self-assessment data, while the second reflects a research question comparing all three strategies for vocabulary word-content assessments.



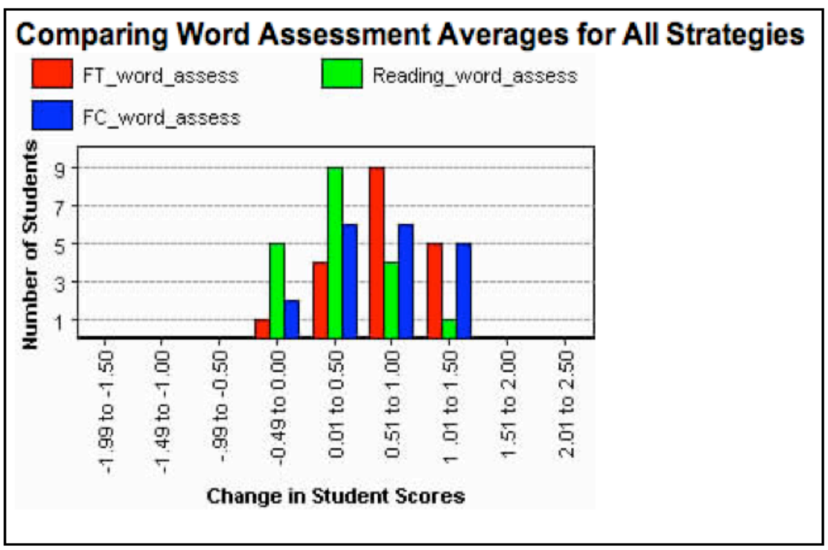


Figure 6. Student results and data analysis: Using graphs to identify data patterns in the Web of Inquiry

In both years, mean results for both vocabulary content assessments and self-assessments showed the field trip strategy to be most effective, with flashcards second-most effective, and reading as minimally effective. Students used the graphs to analyze their data and provide additional information to compliment the results of class averages for each strategy, learning along the way, for instance, the impact an outlier could have on an average. In analyzing the histograms, students often saw the tallest bars or peaks in the middle and thought that strategy represented the highest amount of growth, but then understood in learning to read the histograms that the highest bars represented the amount of growth that most students made, and if that was in the middle of the X-axis, that was not as much as if it was on the far right side of the X-axis. Students then began counting and comparing the number of students who made more than one column's growth for each strategy as a way to compare strategies (5 for flashcards, 5 for field trip, 1 for reading), or that made more than a half column's growth or more (11 for flash cards, 14 for field trip, 5 for reading). Students used the patterns in their data as evidence in evaluating each of their hypotheses, considering whether each was supported by their data. Then, they synthesized these findings. They often further developed their argument with additional theories for why one learning theory proved to be more supported, plausible, or successful than an alternative theory, based on their experiences as participants, and created their 'Current Best Theory,' for example:

> Our current best theory is that field trips work well for learning new words because you can see the words in action, but you have to choose the right place or else you can't learn the words. Reading and flashcards are helpful too, but don't do as well as field trips so maybe people should go on field trips to learn new words more often in addition to reading and flashcards.

Students in a separate workspace are prompted by the software to provide an explanation for their theory. The following is the same group's explanation for the above Current Best Theory:

> Field trips might be best because you can see the words in action and then you are more likely to remember because it is in your head. Flashcards seemed like there were a lot more words because you are reading them and writing them. Your attention is spent finding the words for flashcards but for field trips your attention is spent on the words because you are looking for them and you can see them, you don't have to write them down.

Finally, students are prompted to provide evidence for their Current Best Theory and to consider other plausible alternative theories that could also explain their findings. The students then considered uses of their theory. Ideas discussed in the whole class for uses of their theory included taking the students' results to the local school board to argue for more money allocated for school field trips and experiences like attending a weeklong Science Camp (something the students were looking forward to doing the following year). Students also thought that other teachers might be interested in their results, that they might pay more attention to thinking about what words students might see and experience on field trips before going on them so they could guide their class in actively looking for them in action, an idea that supports both students and teachers in becoming more word-conscious.

The students then reflected on future research building on their Current Best Theory. These topics encompassed a wide range of ideas (see Table 5 below), including the idea of studying a toddler sibling, how children learn their first words, and how people develop language in general.

TABLE 5
Extending Theories – Future Research

- To study how people's minds work, how people learn to speak
- To allowing more time for each theory and see if one theory needs more time than another
- To compare how the three learning theories work with social studies, specifically California missions since students were beginning to learn about them and were planning a field trip to a mission
- To look at other learning theories that involve learning words in conversations, at home, asking your parents, seeing them around town
- To conduct the same research with a new age group, with toddlers the results might be very different
- To see if combining learning theories would help understand new words, like reading a book about something before going on a field trip
- Do some learning theories last longer in memory?

II. Analysis of Changes in Students' Theories Shown in the Word Learning Theories Assessment

In order to identify and understand the nature of changes in students' theories of word learning following their participation in the curricular environment, I conducted several analyses of the Word Learning Theories Assessment. The results of these analyses are presented below. First, I present results of quantitative analyses of Likert scale items from Parts 2 and 3 of the assessment, respectively. Next, I present a qualitative analysis of experimental students' open-ended responses to questions in Part 1. For all three parts, I also present results from analyses of ELs' responses to determine the impact of the learning environment on students from culturally and linguistically diverse backgrounds. Finally, I present the results of an analysis of experimental students' open-ended justifications for Likert items in Parts 2 and 3, in order to develop a beginning taxonomy of students' metacognition about word learning.

Analysis of the Likert scale responses (Parts 2 and 3). Quantitative items of parts two and three of the Word Learning Theories Assessment reflect and test for the presence of a sociocognitive theoretical stance towards the purpose, strategies, and contexts for learning new words, with high scores[4] on such items suggesting students' overall orientation towards the *complexity of word learning*, as opposed to a predominant view of word learning equated with looking up definitions, as something one needs to do for school assignments, or to study for tests (see Appendix C for Word Learning Theories Assessment). As described in the methods section (p.33-4), in Part 2 of the assessment, students agree or disagree with statements using a four-point Likert scale, such as "Knowing a word is the same as knowing its definition." In Part 3 of the assessment, students view a video of students deliberating about learning strategies to use, and agree or disagree with a particular student's view (or agree or disagree equally with both students) using a five-point Likert scale.

Analysis of agree-disagree items (part 2). A repeated measures analysis of variance of the Likert scale responses for items in part two of the assessment indicates

[4] This refers to the scores after reflecting responses for items.

that the curricular experience led to significant gains in students' orientation in the experimental classes presenting a sociocognitive theoretical view of word learning ($F_{(1,78)}$=5.91, p = 0.01 with an effect size of 0.7σ), while there was no significant change for students in the comparison classes. In applying the General Linear Model to conduct the repeated measures ANOVA, I introduced year as a variable in order to identify whether there were differential performances by cohorts receiving the experimental curriculum in a given year. The results of the analysis showed a significant two-way interaction of the dependent variable (pre-post) by condition (experimental-control) reported above, but it also revealed there was no significant interaction for pre-post by year ($F_{(1,78)}$=3.48, p=.066). The pretest means for both experimental and comparison groups in both years were comparable, indicating that the cohorts of students, regardless of placement class or year, had a similar profile in their performance on part two of the assessment at the beginning of fourth grade. Meanwhile, posttest means for the experimental groups both years went up a comparable amount, while the posttest scores for the comparison class cohorts stayed the same (year two) or went up minimally (year one). These results are reported in Table 6 below, and demonstrated in the graphs in Figures 7 – 9.

TABLE 6
Mean Scores on Word Learning Theories Assessment: Part 2

	Experimental or Control	Year	Mean*	Std. Deviation	N
Part 2 Pretest	Experimental	Year 1	2.50	.57611	19
		Year 2	2.55	.33325	23
		Total	2.53	.45370	42
	Comparison	Year 1	2.50	.25465	19
		Year 2	2.37	.37811	21
		Total	2.43	.32705	40
Part 2 Posttest	Experimental	Year 1	2.93	.34766	19
		Year 2	2.76	.25829	23
		Total	2.84	.30904	42
	Comparison	Year 1	2.65	.41881	19
		Year 2	2.36	.35474	21
		Total	2.50	.40871	40

* for 4-point Likert scale, where 4 is highest rated response

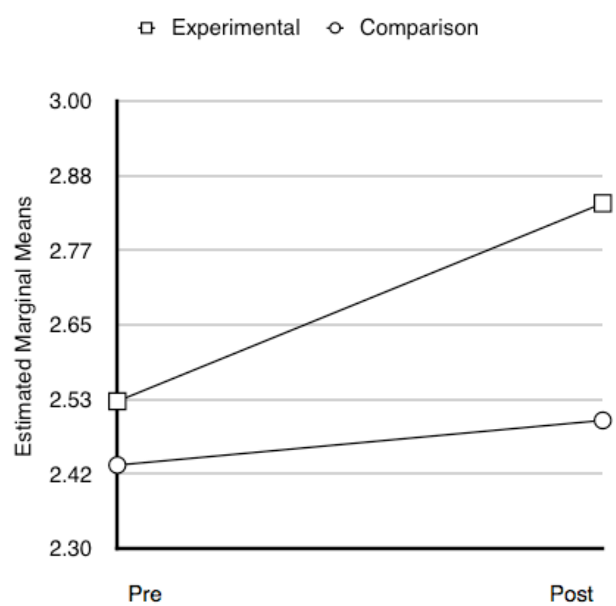


Figure 7. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 2 (Both Years)

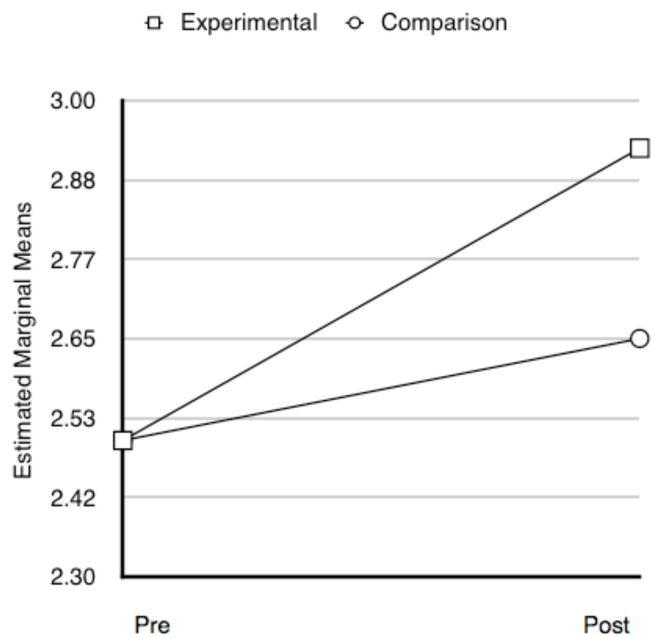


Figure 8. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 2 (Year 1)

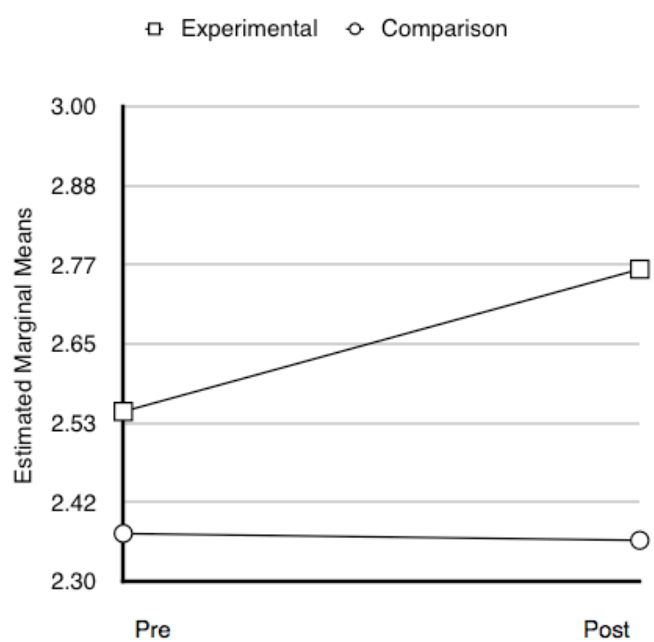


Figure 9. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 2 (Year 2)

Analysis of video scenario items (part 3). Video scenario questions cover similar learning theories represented in agree-disagree statement items. The main difference between these two parts of the assessment is that agree-disagree statement questions relied on students to not only understand the learning theory embodied in the statement, but to infer the competing theory or alternative theory exemplified in the situation presented to them. Items in part two varied equally in their directionality, according to whether they were worded to align with, or embody, a sociocognitive theoretical stance, or to represent a more traditional, predominant stance. In the scenario questions in part three, where two fourth-grade students deliberated the merits and strength of competing theories, students had *both* theoretical positions presented to them. In the scenario items, students were also presented with learning theories that were situated, that is, that were representing learning theories in the context of use. This provided students with examples of how competing theories might be applied and put to use in real-life contexts that they, as students, were familiar with. For these reasons, I hypothesized that the scenario questions may be easier for students to understand and answer.

As was the case with part two Likert questions, a repeated measures analysis of variance of the Likert scale responses for questions in part three of the assessment also indicates that the curricular experience led to significant gains in students' orientation towards a sociocognitive theoretical view of word learning as described in the methods section ($F_{(1,78)}=14.255$, $p <.001$ with an effect size of .9 σ), with no significant change for students in the comparison class. As in the results for part two, this analysis revealed a significant two-way interaction of the dependent variable (pre-post) by condition (experimental-control). Furthermore, this analysis also showed there was no significant interaction for pre-post by year ($F(1,78)=2.52$, $p=.117$). As also was the case with part two, the pretest means for both experimental and comparison groups in both years were similar in their baseline performance, while posttest means for the experimental groups both years went up as those for the comparison class cohorts went down slightly in year one and went up very slightly in year two. Results for this analysis are reported in Table 7 below, and in Figures 10 - 13:

TABLE 7
Mean Scores on Word Learning Theories Assessment: Part 3

	Experimental or Control	Year	Mean	Std. Deviation	N
Part 3 Pretest Mean	Experimental	Year 1	3.12	.80978	18
		Year 2	3.12	.61956	23
		Total	3.12	.69987	41
	Control	Year 1	2.95	.72449	20
		Year 2	3.07	.49233	21
		Total	3.01	.61137	41
Part 3 Posttest Mean	Experimental	Year 1	3.68	.63175	18
		Year 2	3.86	.53726	23
		Total	3.78	.57992	41
	Control	Year 1	2.79	.58578	20
		Year 2	3.25	.70850	21
		Total	3.03	.68497	41

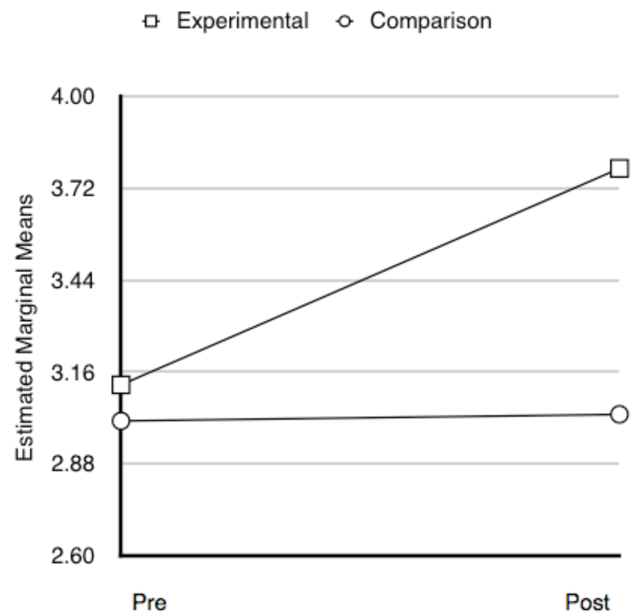


Figure 10. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 3 (Both Years)

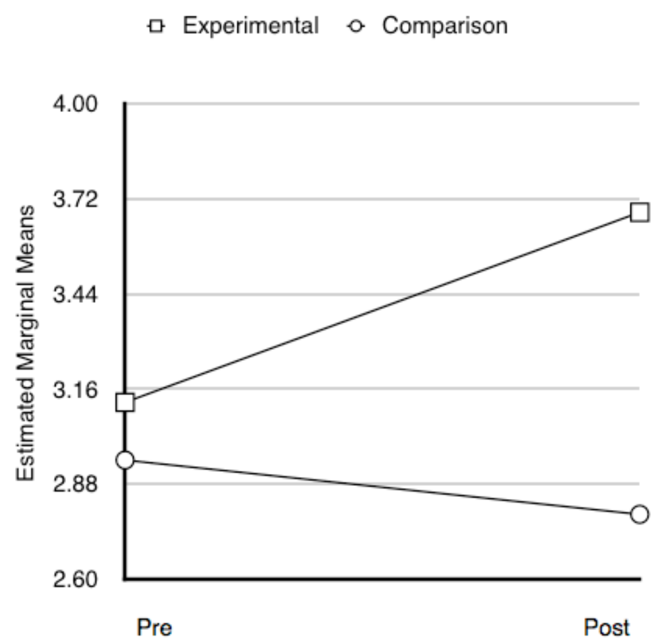


Figure 11. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 3 (Year 1)

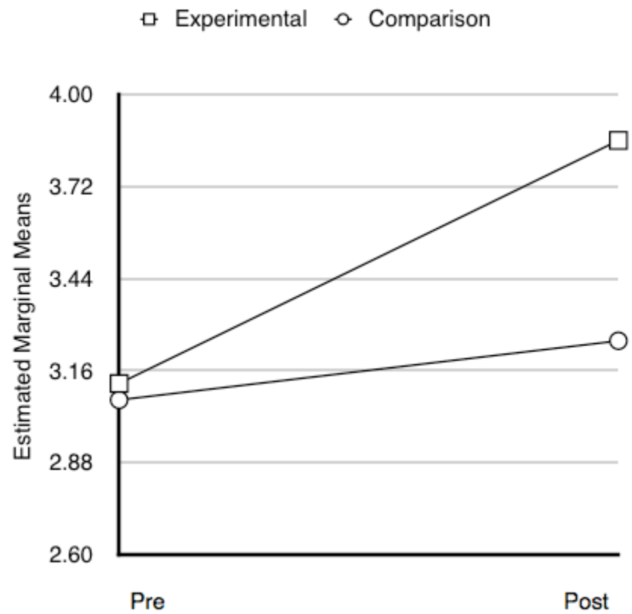


Figure 12. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 3 (Year 2)

Results from analyses of both the agree-disagree statements and scenario questions are consistent in showing the significant impact of the experimental curriculum on students' development of a sociocognitive theoretical view of word learning. Finally, these results also confirm the hypothesis that performance on scenario items, which presented competing theories of peers in a familiar, real-life context, would be better than those in part two, which required evaluating decontextualized theory-statements.

The results were consistent both years. That is, analyses of both agree-disagree statements and scenario items found no significant interaction with year. This analysis shows that there was no significant difference in the way the curriculum was carried out or in the group of students from year to year, and that the second year can be regarded as a replication. Since there is no need to analyze the assessment separately by year, the entire dataset may be used in conducting further analyses, increasing the sample size for both experimental and comparison groups, as well as for ELs within each group. While the theories, prior knowledge, and life experiences of the individual students in a class each year inevitably vary, influencing the direction of class and group discussions, such variations did not significantly influence the outcomes on this assessment.

Comparing responses of English Proficient and English Learner students. In order to understand whether the learning environment was effective for students from culturally and linguistically diverse backgrounds, I conducted a separate repeated measures analysis of variance for ELs to see if their word learning differed from that of the EP students. ELs were designated as such by the school in accordance with state guidelines. Non-English Learner students in the class were either designated as "Fluent English Proficient" under the state guidelines or "English Only." Together, I called this group "English Proficient" (EP). In initial analyses, I found no interaction between Fluent English Proficient and English Only students with the class year, so I combined data for the two years to increase the sample size.

In modeling the repeated measures analysis of variance for the agree-disagree statements, condition (experimental or control) and language proficiency (EL or EP) served as the independent variables, and performance on the Word Learning Assessment (pre-post) served as the dependent variable. Results indicate that the curricular experience led to significant gains for both ELs' and EPs' orientation towards a sociocognitive theoretical view of word learning. However, what is particularly noteworthy is that this effect was greater for EL students, with a triple interaction present between language proficiency, condition, and the pre-post dependent variable ($F_{(1,82)}$=9.57, p =.03). This result indicates that the curriculum, while having significant effects on all experimental students, made a differential impact on EL students, as there was a significantly greater change realized by the ELs. The means (in Table 8 below) show that the ELs experienced a greater benefit from the curricular ideas, seen in their greater growth on part two of the Word Learning Theories Assessment.

TABLE 8
Mean Scores by Language Proficiency on Word Learning Theories Assessment: Part 2

	Experimental or Control	Language Proficiency	Mean	Std. Deviation	N
Part 2 Pretest	Experimental	English Learner	2.44	.44319	16
		English Proficient	2.58	.45966	26
		Total	2.53	.45370	42
	Control	English Learner	2.43	.31857	11
		English Proficient	2.43	.33573	29
		Total	2.43	.32705	40
Part 2 Posttest	Experimental	English Learner	2.83	.34691	16
		English Proficient	2.84	.29054	26
		Total	2.84	.30904	42
	Control	English Learner	2.31	.48438	11
		English Proficient	2.57	.35806	29
		Total	2.50	.40871	40

Finally, in order to understand the impact of this curriculum on EL and EP students, I compared effect sizes for each group. The effect size for the EL group, .91σ, is greater than that of the EP group, which is .57σ. In looking at the plots (Figures 13 and 14 below), we see clearly that the ELs in the experimental group increased their scores at a higher rate, and while starting lower than the EP experimental students, ended with about the same performance on this measure. Meanwhile, we also see that the comparison groups for EP students made slight gains (though not statistically significant) while the comparison ELs show a decline on the measure.

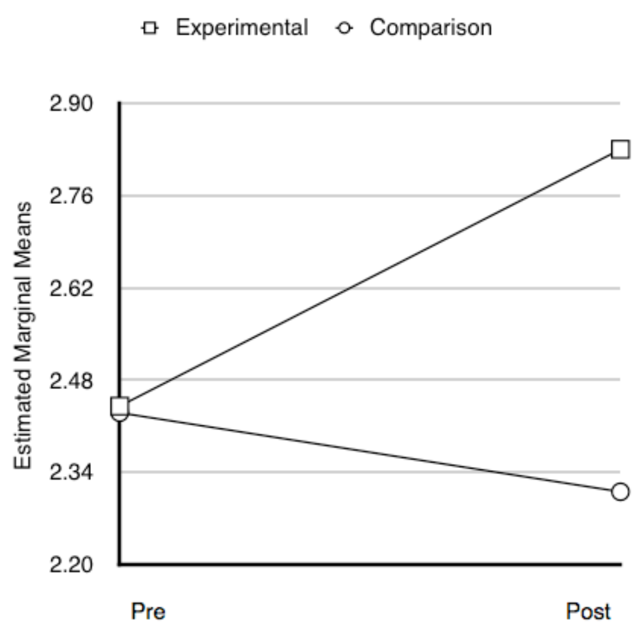


Figure 13. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 2 (English Learners)

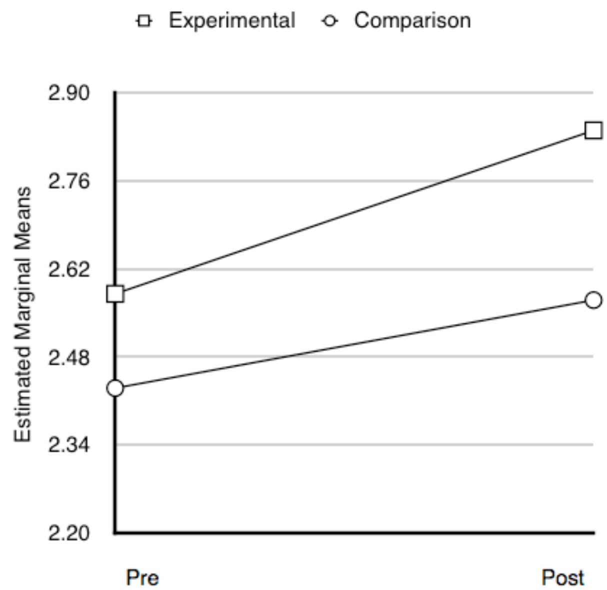


Figure 14. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 2 (English Proficient)

A similar pattern is present in the results of a repeated measure analysis of variance for part three of the assessment, the scenario questions. There was a significant difference between the experimental and comparison on the pre-post measure, as well as a triple interaction with condition, language proficiency, and performance. In the experimental group, ELs gained on this measure at a higher rate than the EP students ($F(1,82)=2.78$, $p = .05$). The pattern of students showing greater learning gains on scenario questions than on the agree-disagree statement questions can be measured by effect sizes. The effect size for ELs' growth on the scenario questions was 1.43σ, while the effect size for the EP group was .76σ, a difference of .67σ. The mean scores for Part 3 are reported in Table 9 below:

TABLE 9
Mean Scores by Language Proficiency on Word Learning Theories Assessment: Part 3

	Experimental or Control	Language Proficiency	Mean	Std. Deviation	N
Part 3 Pretest Mean	Experimental	English Learner	2.66	.46823	15
		English Proficient	3.39	.67784	26
		Total	3.12	.69987	41
	Control	English Learner	2.99	.55799	12
		English Proficient	3.02	.64147	29
		Total	3.01	.61137	41
Part 3 Posttest Mean	Experimental	English Learner	3.59	.62484	15
		English Proficient	3.88	.53576	26
		Total	3.78	.57992	41
	Control	English Learner	2.90	.89547	12
		English Proficient	3.08	.58766	29
		Total	3.03	.68497	41

In Figures 15 and 16, you can see how the ELs in the experimental class started lower than those in the comparison class, with a mean of 2.66 compared to 2.99 for the comparison class, but went on to make considerable gains, with a mean of 3.59 for the posttest, not quite reaching the posttest mean for the EP group of 3.88 (see Figure 16). Meanwhile, the ELs in the comparison class started higher (with a mean of 2.99), but they went down slightly, with a posttest mean of 2.90. The comparison class' EP students also went up slightly (from 3.02 to 3.08), though these results are not significant.

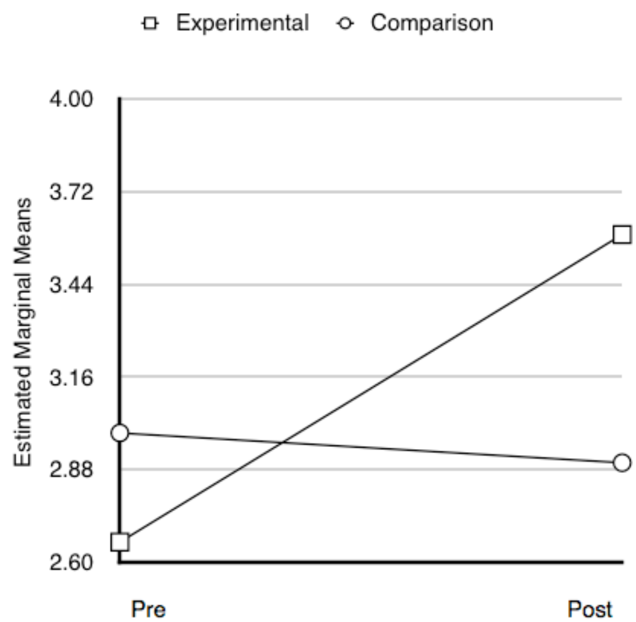


Figure 15. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 3 (English Learner)

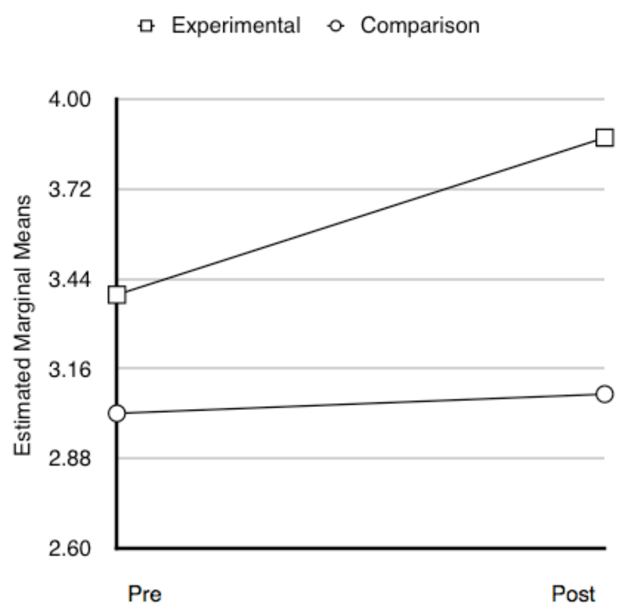


Figure 16. Repeated measures analysis of variance for Word Learning Theories Assessment; Part 3 (English Proficient)

Overall, the results from these quantitative analyses of the Word Learning Theories Assessment demonstrate not only that the experimental learning environment made a difference for students in developing their theoretical and metacognitive stance towards learning words, it made an even greater impact on students from culturally and linguistically diverse backgrounds who are learning in their second language. This is consistent with the hypothesis that students who are already learning and using multiple languages, when given the scaffolding and opportunity to reflect on their processes for learning and using language, would be even more capable of developing a meta-language for talking and way of thinking about their own thinking in the context of language learning. Furthermore, these results show that students from culturally and linguistically diverse backgrounds, by conducting collaborative inquiry into their own theories of how they learn language, can develop a theoretical orientation towards a sociocognitive and situated view of word learning in which metacognitive capabilities are fostered and utilized in considering how, when, and why to apply their particular learning theories.

Analysis of open-ended questions (Part 1). Quantitative analyses reported above provide a basis for conducting a qualitative analysis of the theories of students who participated in the experimental curriculum. This section includes an analysis of students' responses to the four open-ended questions, (1) Why do people learn new words? (2) When do people need to learn new words? (3) How do people learn new words? and (4) What does it mean to know a word? As described earlier, coding schemes were developed to detect emergent patterns in student responses for each, as well as predetermined theoretical constructs that students were predicted to develop through their participation in the curriculum. In Table 10 below, I provide examples of students' theories and responses, along with coding categories, and the number of theories each was coded as containing.

TABLE 10
Coding Examples: What Counts as a Theory?

Question 3: How do people learn new words?		
	Pretest	Post-test
Coding Categories	Coding Categories: • Hearing someone else say words • In school, spelling tests • Looking them up in the dictionary	Coding Categories: • Seeing words in action, experiencing them on field trips • Reading, using context • Conversation, communicating, talking with someone
Students' Theories	"People learn new words by going to school." (Experimental Group Student)	"People can learn a new word by studying flashcards, by reading what the word means or by going on a field trip." (Same Experimental Group Student)
Number of Codes	1 theory coded: School	3 theories coded: Field trip, flashcards, reading

Average number of theories for the open-ended questions. In analyzing the four open-ended questions, I first compared changes from pretest to posttest in the average number of theories per question students presented in answering the four open-ended questions. Since the curriculum supported students' appropriating the notion of having multiple theories and strategies for word learning that depend on multiple factors, I hypothesized that students, who have become more aware of the complexity of word learning, different theories for learning, and a variety of considerations for when to apply them, would present more theories in the posttest after participating in curriculum. Such a finding would be indicative of an awareness that there is more than one way to learn, and would also align with students' metacognitive awareness in employing different learning theories and strategies actively and strategically as tools for their own learning. For students in the experimental class, the average number of theories per question was 1.88 in the pretest and 3.70 in the posttest, and this increase is significant ($F_{(1,80)}=55.01$, $p<.001$), while in the comparison class the average number of theories decreased from 1.84 to 0.71. The findings of this repeated measures analysis of variance show a significant interaction between condition and pretest-posttest as reported above, with no interaction by year or language proficiency. Therefore, the effect of the curriculum on increasing students' theories in response to the open-ended questions was significant for both the EP and EL experimental groups, for both years. Pretest means show that the starting levels for all groups were comparable. In looking at the mean number of theories for all questions, the experimental group doubled the total number of theories for all four questions, offering an average of 7.5 in the pretest compared to 14.8 in the posttest, while the comparison class pretest mean across all questions was largely unchanged with 7.4 theories offered in the pretest and 7.9 in the posttest.

TABLE 11
Average Number of Theories for Open-Ended Questions

	Average Number of Theories Per Question	
	Experimental (n=41)	Comparison (n=39)
Pretest	1.88	1.84
Posttest	3.70	0.71
	Average Number of Theories for All Questions	
	Experimental (n=41)	Control (n=39)
Pretest	7.5	7.4
Posttest	14.8	7.9

Next I compared the number of theories students offered in response to each question (see Table 12 below). Interestingly, for both groups the lowest average number of theories on the pretest was in response to question four (What does it mean to know a word?), with the experimental group's average being 1.55 and the comparison group's average being 1.38. This is not unexpected, as this was a conceptually challenging question, asking fourth-grade students to articulate their epistemological views of what constitutes word knowledge. While this question had one of the lowest posttest averages for the experimental group (along with question one, why do people learn new words), the mean was double that of the pretest at 3.02 (the posttest mean for question one was 3.0). Questions two (when do people need to learn new words) and three (how do we learn new words) had the highest posttest averages for the experimental group, with a posttest average of 3.71 and 4.90 respectively. These results are also not surprising, since both of these questions are more tangible to students, asking them to consider theories as applications of when and how. They also align with students' inquiry research, investigating how students learn scientific vocabulary. Questions one and four are more ideological and abstract, asking for students to articulate their epistemological beliefs about word knowledge and the purpose for acquiring it.

TABLE 12
Average Number of Theories for Individual Questions

	Experimental		Comparison	
	Pretest	Posttest	Pretest	Posttest
Why do people learn new words?	1.98	3.00	1.83	1.95
When do people need to learn new words?	1.67	3.71	1.95	1.93
How do people learn new words?	2.26	4.90	2.21	2.44
What does it mean to know a word?	1.55	3.02	1.38	1.60

In addition to understanding fourth-grade students' capacity to develop theories about how, when, and why they learn words, students' pretest responses to the open-ended questions indicate that the assessment may be instructive as well. The formative aspect of this assessment is expected since it is likely many students had not contemplated questions such as how or why people learn new words, and yet when prompted with these questions, students from both the experimental and comparison classes offered a broad range of diverse theories from the act of reflecting upon their learning processes. The total number of emergent codes representing different theories present in student responses to each of the questions in both pretests and posttests (Table 13 below) was impressive for both groups. The breadth of emergent codes gives some indication of how rich the students' understanding is in terms of the number of different theories they express. Collectively, students in both groups provided over twenty different theories in response to each question on the pretest, and for question three (how do people learn new words), 38 different theories coded in posttest responses across both groups. For the complete list of emergent and predetermined codes applied to the four open-ended questions, see Appendix G.

TABLE 13
Total Emergent Theory Codes by Question

Both Groups (n=80)	Question 1	–Question 2	Question 3	Question 4
Pretest	29	33	29	28
Posttest	32	32	38	37
Experimental (n=41)				
Pretest	25	26	25	27
Posttest	27	28	36	38
Comparison (n=39)				
Pretest	23	22	27	24
Posttest	26	25	23	24

The finding that fourth-grade students are indeed capable of generating numerous theories about how they learn language when offered the opportunity is itself useful for informing learning theory, curriculum development, teaching practices, and assessment. Moreover, the experimental group developed even more of a range of theories in posttest responses, particularly in response to questions three (how do people learn new words) and four (what does it mean to know a word). This is remarkable because students, in their inquiry projects, tested only three representative strategies that aligned with learning theories they had, yet in their posttest they offered many more theories than just those which they investigated in their research. This suggests that the collaborative inquiry process into one's own theories for learning serves as a generative, metacognitive process which makes students more aware of their own—and others—multiple ways of learning.

Findings for individual open-ended questions. For each of the open-ended questions in part one of the assessment, I analyzed results for patterns in both emergent and predetermined codes present in the experimental group responses, in order to further characterize, understand, and interpret changes in experimental students' thinking after having engaged in the experimental curriculum. This detailed analysis focused on experimental student responses, having determined that there was an overall significant difference between the experimental and comparison classes on all three parts of the Word Learning Theories Assessment.

To identify initial patterns in responses across the experimental group for each question, I began by calculating the total count for each coding category for each question, and the percent of students in the class whose ideas were coded as expressing the theory that each coding category represented. After identifying patterns in experimental student responses, I tested for differences in pretest and posttest responses for a number of the coded variables using the McNemar test for two level dichotomous data (comparing two different proportions) with repeated measures, using a binomial distribution to calculate the exact probability or the McNemar Test Exact Significance (2-sided). This allowed me to explore whether patterns of changes in responses from pretest to posttest were statistically significant.

Results for the first question, why people learn new words, are reported in Table 14 below. Emergent patterns for why people learn new words included to communicate, to learn new meanings, and for a job or profession, with learning new words to communicate with others (p=.004), and developing a language of practice necessitated by working in a new job or profession (p=.008) being the two categories which showed statistically significant changes.

TABLE 14
Experimental Group Findings from Question 1: Why People Learn New Words

Patterns in Student Responses	Pre	Post	McNemar Test Exact Significance (2-sided)
Emergent Patterns			
To communicate	33%	64%	p=.004*
To learn meanings	5%	21%	p=.065
For a job or profession	5%	25%	p=.008*
Predetermined Patterns			
Sociocognitive, social purpose	41%	64%	p=.05*
Situated, Context of Use	7%	50%	p=.003*

* = Significant difference   Experimental Group, n=42

For the analysis of predetermined theoretical constructs, one category identified a sociocognitive or social purpose for learning new words. Student responses that were coded as involving social interaction or that regarded word learning as a social activity required students to have explicitly articulated communication between people in their response, such as talking, learning from people, learning from a teacher, listening to a conversation, etc. This coding category required interaction between people to be direct and in person, so movies and such were not coded as having this construct present. Results indicate that following their engagement in collaborative inquiry, more students offered theories that reflected a social purpose for learning words (p=.05). In addition, it is worth noting that the pretest responses were the highest to begin with in this category (41% of responses), and that by the end of the curriculum, 64% of the experimental class offered responses that recognized a social purpose for learning new words. They recognized that an important goal for learning new words and language is to facilitate and improve communication for a wide number of purposes. An example is one student's post response to this question: "So they can communicate, and also so they can talk to friends and also understand what people want to tell them."

Students' responses were also coded for the predetermined theoretical construct of word learning being situated. Responses coded for this construct required that they presented word learning as being specific to a context of use. That is, in their theory or strategy, students represented the purpose of learning words as being specific to their use in a given situation, or the purpose of word learning being brought about by a situation (some examples coded for this include learning words in a doctor's office, learning a new language while traveling, while shopping, etc.). Overall, more students expressed a greater awareness of a situated purpose for learning words, dependent on the diverse contexts in which one finds oneself needing to learn them, in posttest responses, and this difference was significant ($p=.003$).

Patterns in responses to the second question, when do people need to learn new words, demonstrated a metacognitive awareness of when, how, and why learning theories might be usefully applied (see Table 15 below). Emergent patterns detected included learning experientially and seeing words "in action", such as while on a field trip or in a museum ($p=.016$), consistent with results from students' own inquiry (as seen in the results describing students' experiences with the curriculum).

TABLE 15
Experimental Group Findings from Question 2: When People Need to Learn New Words

Patterns in Student Responses	Pre	Post	McNemar Test Exact Significance (2-sided)
Emergent Patterns			
In School	50%	55%	p=.80
Community (clubs, soccer, downtown, etc.)	2%	33%	p=.001*
Experiential learning (museum, field trip)	0%	17%	p=.016*
Traveling, vacation	0%	17%	p=.016*
Predetermined Patterns			
Anticipating specific situations	14%	45%	p=.002*
Situated, context of use	0%	30%	p<.001*
Sociocognitive, social purpose	17%	43%	p=.013*
In *and* Outside of school	42%	75%	p=.03*
Word Learning as Incidental	2%	26%	p=.006*

* = Significant difference Experimental Group, n=42

Another pattern detected was an increased awareness that people need to learn new words when traveling, either during a trip or in preparation for one (p=.016). The largest category for this question identified school as a context for needing to learn new words, with 50% of students identifying this in their pretest responses and 55% in their posttest responses. Interestingly, the largest category in posttest responses from students in the comparison class identified spelling tests as a situation when people need to learn new words, indicating that they more often equated learning new words—and word knowledge itself—with learning how they are spelled.

Finally, student responses to this question demonstrated a metacognitive awareness that there are multiple contexts when specific vocabulary and certain kinds of words would be needed. A significant percentage of experimental students showed an increase in awareness that applying word learning theories in anticipation of a variety of specific situations and contexts is helpful, rather than simply learning words in the moment they are needed (p=.002). Experimental group students showed an increased awareness that word learning is not only something that they encounter in school, but that it is something that occurs in their community (clubs, soccer, downtown, etc., p=.001), and is situated in the context of use (field trips, in museums, traveling, p< .001). Significantly more students including the presence of *both* school and outside of school contexts in their responses (p=.007), showing growing awareness of the importance of word learning in the many domains of their lives, as the following examples illustrate:

> It might be important when you have a test coming up or maybe when someone uses a word you don't know or going on a trip.
>
> You need to learn new words when you get a new job, go to a trip, take a test and when they tell you to give the definition.
>
> To teach other people, to do a test, essay, schoolwork, to do their job, to do a special event, to study habitats.

Lastly, more students also recognized following their inquiry that learning words is something that one does out of necessity in social contexts without making it an explicit goal. That is to say, more students recognized that word learning occurs incidentally in authentic situations through incremental exposure to words in use (p=.006), rather than words learned as an explicit, discrete, decontextualized task for a school assignment or test. This was also consistent with the finding that more students' posttest theories involved social interaction, regarding word learning as a social activity ($p=.013$), such as talking or learning from other people, such as a teacher or family member, listening to a conversation, and so on.

In response to the third question, “How do people learn new words?” emergent patterns in experimental group posttest responses were consistent with the results of the learning strategies they tested in their inquiry research projects (see Table 16 below), including that people learn new words from context while reading (n.s., $p=.06$), by using flashcards ($p<.001$), and experientially while on a field trip (experiencing the word, seeing it in action, $p<.001$). This outcome reflects the types of experiences students had while participating in the curriculum, having focused on these learning strategies. Eighty-six percent of students, after participating in the curriculum, offered theories explicitly related to the learning strategies that they tested in their own inquiry research, as one student response illustrates, “In our experience we learned words by studying them as flashcards, reading, and field trips but there's even more.”

TABLE 16
Experimental Group Findings from Question 3: How People Learn New Words

Patterns in Student Responses	Pre	Post	McNemar Test Exact Significance (2-sided)
Emergent Patterns			
From context while reading	42%	64%	p=.06
Using flashcards	0%	38%	p<.001*
Field trip	0%	43%	p<.001*
Experientially	0%	33%	p<.001*
In community context	2%	26%	p=.002*
Percent offering 3 or more ‘other’ theories	21%	43%	p<.001*
Predetermined Patterns			
Situated, in context of use	38%	81%	p<.001*
In *and* outside of school	17%	48%	p=.002*
Gives multiple strategies for learning	55%	88%	p<.001*
Word Learning as incidental	62%	81%	p=.04*
Aligns with word learning literature	38%	60%	p=.004*
Posttest aligns with Web of Inquiry strategies		86%	

* Significant Experimental Group, n=42

In some cases, students applied the core idea of a learning theory from their inquiry research to a new situation, suggesting the use of *context* as a strategy for troubleshooting unknown words more generally, and while reading any text, not just a science textbook, saying, “I think people learn new words by seeing them in action, hearing people use them, use the context, flashcards,” and “By seeing them in action, seeing the definition, and reading in context.” Students also explained how a more knowledgeable ‘expert’ other might scaffold understanding of concepts and their accompanying words indoors, rather than outside while investigating an ecosystem. As one student put it:

> The teacher teaches them, spelling tests, your parents teach you, they go to a place, for example the aquarium, the person that leads you around tells you what things are and you learn that word, you hear it around and you ask somebody and they tell you what it means.

While more students offered multiple strategies for learning words on the posttest, 88% of the students in their posttest responses included both theories they tested in the curriculum as well as 'other' theories *in addition to those they tested*, and 43% of the students even included as many as three or more 'other' theories in their single posttest responses (compared to 21% in their pretest responses). Some examples of responses of this type include: "People learn new words in a dictionary. Also in a book, in [an] atlas, in school, in the store, in your house, with your friends, at another house, flash cards, and field trips," and, "Reading, going on a field trip, flash cards, making art with words in it. Or just looking around the room. Going on the internet."

The fact that students in their posttest responses not only offered theories directly related to those tested in their inquiry projects, but also offered other theories—and even more of them—gives an indication of the impact of engaging students in inquiry into their learning theories, on the number and the variety of theories for learning words students acquire. It would seem that inquiry into one's own learning processes in this context had a generative impact, and led students to develop metacognitive awareness of even more theories for learning than those with which they engaged.

Further analyses of students' theories and responses to the question "How do people learn new words?" are also consistent with patterns found in analyses of earlier questions. For example, students in their posttest responses showed a greater awareness of word learning being situated in the context of its use than in the pretest ($p<.001$). While students in response to this question already had a sense that such learning takes place within social interactions (40% of pretest responses and 45% of posttest responses), students posttests indicate that more students began to recognize that such learning occurs not only in school, but all around them within their community ($p=.002$). Furthermore, almost half the students in their posttest responses included both in school and outside of school contexts within their learning theories compared to in their pretest ($p=.002$). These findings are consistent with the curriculum, which stressed that there are multiple ways for learning words that are suitable for, and that may be chosen to meet specific goals, needs, purposes, and situations. Examples of posttest responses illustrating these findings include: (1) “People learn new words by reading, looking up words, doing research, talking, in school, songs, playing with letters, and shopping,” (2) “By having conversations, by being taught in school or out, on signs on the street,” and (3) “School, home, downtown, classes, playground, other houses, on field trips, vacations, work (if you go to work), in books, with friends, in the car, little trips, etc.”

Finally, in an analysis of predetermined theoretical constructs coded for this question, students’ awareness that word learning is incidental increased as well ($p=.04$). This seems to be related to a developing awareness that word learning is situated in the context of use, as well as an expanded awareness of the domains of one’s life and experiences where one engages in word learning, as in such situations—unlike many academic tasks—learning a new word is often an unintended consequence of activity rather than the explicit focus or goal. However, students not only developed an awareness of word learning being incidental, they came to understand and theorize about the process by which words are learned incidentally. One student (an EL) in his pretest response offered "Maybe when the teacher reads a book, the kids learn new words," a school context which could be either an explicit or incidental word learning situation depending on whether the teacher or students ask questions about, emphasize, pay attention to, or explain words as part of discussion. In his posttest response, the same student illustrates his understanding of how word learning can be incidental, but explains how he believes this mechanism works in an outside of school context: "People may learn new words by watching T.V. because the T.V. doesn't always give you words you know, the T.V. is going to give you scientific words and sometimes it explains it and you just learn a new word."

When coded for a composite variable of whether students' theories aligned with predominant learning theories within the research literature, such as whether word learning is viewed as incidental, situated within the context of use, or relies on multiple exposures, wide reading, family or more expert others as vocabulary coaches, 60% of students' posttest responses showed such alignment compared with 38% in the pretest ($p=.004$). Examples of responses aligning with word learning research include: "By getting multiple exposures to it, going on a field trip, reading, making flashcards," and "I think people learn new words by seeing them in action, hearing people use them, use the context, flashcards."

Finally, experimental group posttest responses to the fourth question, "What does it mean to know a word?" showed some very promising results. Pretest responses from the experimental group were idiosyncratic, with some patterns of responses equating word knowledge with knowing word meanings (19%), being smart and successful (14%), and knowing how to use a word in a sentence and being able to write it (12%). Students' responses from the comparison class were also idiosyncratic in both pretest and posttests, though one pattern equated word knowledge with behaviors of paying attention and practicing (27%). Common posttest responses for students in the comparison group equated word knowledge with knowing definitions (22%) and being able to say a word (17%).

The impact of students' experience participating in the inquiry curriculum was evident by the fact that in the posttest, 55% of the experimental students referred to their project and/or strategies they tested in their inquiry when answering this question, and 31% actually offered an example from their inquiry project in their response. Experimental students' posttest responses indicate more students developed an epistemological stance that knowing a word is more than knowing a meaning, that word knowledge entails being able to use a word in multiple contexts, knowledge of what a word is related to, and having experience with and a deeper understanding of the concept that word represents (see Table 17 below).

TABLE 17
Experimental Group Findings from Question 4: What it Means to Know a Word

Patterns in Student Responses	Pre	Post	McNemar Test Exact Significance (2-sided)
Emergent Patterns			
Know how to use it correctly in different ways, contexts	12%	41%	p=.004*
Can define it	7%	31%	p=.013*
Can picture word and what it's related to	0%	17%	p=.016*
Can give an example, synonym	5%	26%	p=.022*
Predetermined Patterns			
Aligns with word learning literature	2%	38%	p<.001*
Situated, in context of use	19%	50%	p=.004*
Word knowledge is schematic, word schemas	0%	24%	p=.002*
Knowing for a given purpose	7%	24%	p=.04*
Understood, gave appropriate answer to question	55%	86%	p=.004*
Refer to strategies tried in their inquiry project		55%	
Refer to their inquiry project		31%	

* = Significant difference   Experimental Group, n=42

Despite the idiosyncratic pretest results to this question, there were a number of patterns in experimental students' posttest responses that were statistically significant. In posttest responses, students depicted word knowledge as being more active and requiring a greater sense of agency. Rather than responding that to know a word is to know a word's meaning, common in pretest responses and in the comparison class' pre and posttest responses, experimental students more often said in their posttest responses that knowing a word entailed being able to define a word, such as when someone asks for a definition (p=.013). Other statistically significant patterns in the posttest show a more active, agentive epistemological view of word knowledge include equating word knowledge with being able to put words to use or know when or how to use them (p=.004), being able to correctly use words in multiple, different ways (p=.021), being able to give an example of a word or a synonym for a word (p=.022), and being able to picture a word and what it is connected or related to (p=.016).

Predetermined theoretical constructs also suggest patterns in the experimental students' thinking following their participation in the inquiry curriculum. Like previous questions, students posttest responses were more aligned with theories found in the *word learning research literature* compared to those in the pretest (p<.001), including a belief that word knowledge itself is *situated in the context of it's use* (p=.004), and that such knowledge constitutes metacognitive capabilities and awareness of *knowing a word for a given purpose* (p=.04). One of the most remarkable patterns that emerged in posttest responses from the standpoint of the research on word learning literature and the goals of the curriculum was that more students in their posttest described word knowledge as being schematic, or comprised of word schemas, than in their pretest (p=.002). Students described such knowledge as being able to picture words, what they are related to, knowing other words and synonyms connected to a word, and learning information about the word (p=.016). Finally, student responses more often represented a view of word knowledge as incremental, including ideas from the rubric the class created for assessing word knowledge for their own analysis. Responses included the highest level of knowledge on the rubric, representing word knowledge as schematic, involving being able to know a word, it's meaning, being able to use it, and knowing and picturing all the things it is related to, as these examples illustrate: (1) "It means to know a word when you know all the concepts and things that relate to the word, and you have to know the definition. You can picture it," (2) "Knowing a word, You can describe it, use it in a sentence, you know the meaning, give other words like it, and draw it," (3) "When you *know* a word you can give an example, and you can give a definition(s), and you can see it in your mind," and (4) "Give many definitions, can use it, you can pronounce it, recognize it being used, picture it, hearing it."

Responses to question four also revealed that students initially either did not understand the question, or did not know how to answer it, illuminating the complexity of the question itself. Some examples of responses coded as showing this confusion included, "It means that you learned a new word," "Maybe you know a word," and "I know a lot of words but this is confusing." A finding perhaps equally important to that of students developing a conception of word knowledge that consists of being able to actively use words in context and construct schematic networks to other related and known concepts, had to do with students' increased success grappling with the sophisticated and epistemologically complex question of what it means to know a word. While approximately half the experimental students' pretest responses indicated they either did not understand the question or they did not know how to answer it (45%), this was the case for only six of the 42-posttest responses (14%). Meanwhile, in the comparison class, 56% of the students in the pretest and 41% of the students in the posttest gave responses that showed such confusion. These results show that after engaging in the curriculum, most of the students (86%) were capable of articulating their theories and epistemological beliefs about word knowledge, while only about half (55%) did so initially.

In looking at the total number of emergent codes for student theories offered in response to the four open-ended questions, the pretest responses to question four were similar in the number of different theories coded (27) to the rest of the questions (29, 26, 25) for the experimental group. While this number was slightly smaller for the comparison pretest responses to question four (24), the experimental group's number of emergent codes increased in posttest responses to 38, which is the largest number of emergent codes present across all of the four questions (compared to 32, 28, and 36 for questions 1, 2, and 3 respectively), while this number stayed the same for the comparison group posttest responses (24). Such a finding demonstrates the richness and complexity in students' developing understanding of word knowledge in terms of the variety in number of different theories they express in describing such knowledge. This is especially exciting when realizing such diversity in students' expression of epistemological knowledge of words is developed in tandem with theories that are fundamental in the curriculum as well, such as those with significant patterns of results described earlier.

Taken together, these results suggest that after engaging in the curriculum, students were more able to reflect on and articulate their conceptions of word knowledge, and that these conceptions were more complex. Students' posttest theories reflected a belief that word knowledge is comprised of more than simply knowing definitions, as one student response demonstrates: "To know the meaning, to use the word in just talking, to use it in teaching, to use it in and outdoors, to use it in other jobs."

Analysis of English Learners' responses to open-ended questions. With the knowledge of the significant differential improvement made by ELs on parts two and three of the Word Learning Theories Assessment, a qualitative analysis of EL performance on part one is particularly relevant. Such an analysis informs us of what theories and metacognitive capabilities ELs developed during their participation in the curriculum, what ideas they came away with, and how they were qualitatively similar or different to those of the EP students. In particular, a hypothesis informed by the theoretical framework of this study and its supporting literature predicts that EP students might be more likely to participate in the dominant culture and its language, English, and have already acquired an academic identity. Having such an identity, such students might take for granted that word learning is something one does in school or for school tasks, or they simply might not be aware of this as they have already been enculturated into and appropriated the language of schooling, particularly if they share the dominant language used in schools as their first language. Meanwhile, it might be hypothesized as well that students from culturally and linguistically diverse backgrounds might show more variety in their theories for the contexts and purposes for learning words, informed by their experiences in needing to learn words across languages in multiple domains of their lives. Table 18 reports results of the analyses of EL and EP responses to open-ended questions.

TABLE 18

Patterns in English Learner Responses to Open-Ended Questions (1-4)

	English Proficient			English Learners		
Patterns in Student Responses	Pre	Post	p value*	Pre	Post	p value*
Patterns for Why People Learn New Words (Qu.1)						
To use to communicate	50%	77%	p=.092	6%	44%	p=.031*
To understand others	27%	23%	p=1.00	6%	25%	p=.38
Situated in the context of use	8%	58%	p=.0*	6%	38%	p=.125
Sociocognitive, social activity and interaction	42%	73%	p=.057	38%	50%	p=.727
Patterns for When People Need to Learn New Words (Qu.2)						
Community (clubs, soccer, downtown, etc.)	4%	31%	p=.039*	0%	38%	p =.031*
Talking to someone, in conversation	8%	19%	p=.375	13%	25%	p=.625
In school	39%	42%	p=1.00	69%	75%	p=1.0
When reading	23%	19%	p=1.0	19%	25%	p=1.0
Situated, context of use	19%	65%	p=.004*	6%	63%	p=.004*
Sociocognitive, social purpose	15%	42%	p=.065	19%	44%	p=.219
In *and* Outside of school	39%	58%	p=.267	13%	63%	p=.008*
Word Learning as Incidental	4%	19%	p=.219	0%	38%	p=.031*
Metacognition in identifying situations	19%	42%	p=.109	6%	50%	p=.016*
Patterns for How People Learn New Words (Qu. 3)						
From context while reading	50%	69%	p=.180	31%	56%	p=.344
Using flashcards	0%	38%	p=.004*	0%	44%	p=.016*
Field trip	0%	46%	p=.0*	0%	38%	p=.031*
Experientially	0%	31%	p=.008*	0%	31%	p=.063
In school	27%	39%	p=.508	44%	38%	p=1.0
In community context	0%	27%	p=.008*	6%	25%	p=.250
Situated, in context of use	50%	89%	p=.006*	19%	69%	p=.008*
Gives multiple strategies for learning	65%	92%	p=.016*	38%	81%	p=.016*
Word Learning as incidental	73%	81%	p=.687	44%	81%	p=.031*
In *and* Outside of school	19%	50%	p=.039*	13%	44%	p=.06
Average no. ‘other’ theories (not tested in Web of Inquiry)		3.1			2.25	
Percent offering ‘other’ theories		100%			63%	
Percent offering 3 or more ‘other’ theories		54%			31%	
Posttest aligns with Web of Inquiry strategies		92%			69%	
Patterns for What it Means to Know a Word (Qu. 4)						
To know it’s meaning	27%	23%	p=1.0	6%	31%	p=.219
Know how to use it correctly	19%	50%	p=.039*	0%	25%	p=.125
Can picture word and what it’s related to	0%	19%	p=.063	0%	13%	p=.5
Can give an example, synonym	8%	27%	p=.180	0%	25%	p=.125
Knowing for a given purpose	8%	15%	p=.625	13%	31%	p=.375
Situated, in context of use	0%	8%	p=.157	13%	38%	p=.219
Aligns with word learning literature	4%	50%	p=.0*	0%	19%	p=.25
Sociocognitive, social purpose	40%	20%	p=.125	13%	25%	p=.625
Understood, gave appropriate answer to question	65%	85%	p=.180	38%	88%	p=.021*
Refer to strategies tried in their inquiry project		73%			25%	
Refer to their inquiry project		15%			25%	

* = Significant difference McNemar Test Exact Significance (2-sided), Experimental Group EPs: n=26, ELs: n=16

While the only pattern evident in the ELs' responses to the question *why do people learn new words* in the pretest for the experimental group identified a sociocognitive purpose for learning words (in 38% of pretest responses), ELs in the experimental group more consistently responded in their posttests that people learn new words to [use them] to communicate compared to in their pretests (p=.031), increasing from 6% of the pretest responses to 44% of posttest responses.

In considering the question of when people need to learn new words, the results of ELs in the experimental group showed similar patterns to those of the whole experimental group. As was the case with EP students, ELs more often reported situations for when people need to learn new words that involved community contexts following their participation in collaborative inquiry into their theories for learning words (p=.031). They also offered more situations coded as being situated, or specific to a situation and context of use for needing to learn new words (p=.004). Patterns in responses for ELs differed from those of EP students as well, with ELs demonstrating greater metacognitive awareness in anticipating and identifying situations where there is a need for learning words driven by a variety of goals depending on your purpose (p=.016). Finally, ELs also offered more posttest responses that included both in school and outside of school contexts in the situations they gave for when people need to learn new words (p=.008), and they included and described more instances and situations for learning words that were incidental on their posttests as well (p=.031).

It is most illuminating that ELs were much more aware of school as a domain for learning words than their EP classmates. ELs included school as a context for needing to learn new words, both on the pretest and posttest, much more frequently than their EP classmates. While 69% of the EL students in the experimental class identified school as a context in which one needs to learn new words on the pretest, only 39% of EP students did so. Similarly, on the posttest, 75% of ELs identified school as a context for needing to learn new words while only 42% of EP students did. Indeed, EL students have a heightened awareness of the need for learning new words brought about by and in academic settings where they are learning in a second language, an awareness that is not nearly as prevalent in their EP classmates. Complimenting this is the finding that while EL students overwhelmingly identified school as a context for needing to learn new words on the pretest, they did not identify outside of school contexts as well. Only 13% of EL students identified both in school and outside of school contexts in the pretest, compared to 39% of EP students. Both groups responses in this category increased considerably, with 50% of the EP students and 44% of ELs students identifying in school *and* outside of school contexts on the posttest. This increase for ELs is significant (p=.008), and noteworthy since not one EL student response on the pretest included a community context as a situation for when people need to learn new words. A sample of posttest EL responses included, "When they call 911 or when they're in a giant meeting and they have to talk, or if they want to explain something important to say or you're in an interesting conversation," "When you talk to someone, when you look in a book, in [an] agenda, in a park, in a class," "You need to learn new words when you get a new job, go to a trip, take a test and when they tell you to give the definition." In the example below, a student gave the example of how he learned a technical term for some type of technology (the name for a type of chip he needed for his game player):

> They learn new words like in college too, if you watch a movie. You can understand it to learn new words. If you go to a store and you need something you asked the worker that you want a game but they say that you need [some kind of a] chip to get this game.

Patterns of responses from ELs to the question *how do people learn new words* were not remarkably different from their EP classmates. Several categories of posttest responses by ELs to this question were statistically significant, most noteworthy of the emergent categories being the learning strategies tested by the students while conducting their inquiry research. Such responses included learning words while on a field trip ($p=.031$), and creating flashcards and then studying them ($p=.016$). Seeing words in action was also mentioned, but was not significantly significant ($p=.063$). Similarly, reading increased from pretest to posttest as well (31% to 56%), but was also not significant. Sixty-nine percent of the EL students' theories for how people learn new words aligned with strategies tested in their inquiry research, similar to the EP group. Both EL and EP students offered multiple strategies for learning in posttest responses, a significant difference from pretest responses in which more students reported only one theory for how to learn new words, with 81% of ELs offering multiple strategies on the posttest ($p=.016$). In addition, half of the EL students went beyond offering only strategies tested in their inquiry research, and include ‘other’ theories (different than the strategies tested in their research) on their posttest, with 25% of these EL students even offering three or more ‘other’ theories. EL students also mirrored the significant results for the whole group in their posttest responses for offering more theories and strategies for learning new words that are situated in particular contexts (p=.008), and which reflect an understanding that word learning may not only be the result of goal-driven action and activity, but can occur incidentally as well (p=.031).

Finally, one area in particular which is interesting to compare EL responses to those of EP students is for theories for learning new words that occur in school and outside of school. Just as EL students more often than EP students identified school contexts as situations for when learning new words is needed, ELs in their pretests also more frequently identified strategies for learning words in a school context than EP students when asked how people learn new words (44% compared to 27%, respectively). In posttest responses to this question, the frequency of identifying strategies for learning words in school contexts went down only slightly for the EL group (from 44% to 38%), while it went up for the EP groups (from 27% to 39%), with both groups’ posttest responses for this category being nearly the same. Meanwhile, in coding responses for explicitly mentioning outside of school contexts from within the community in their learning strategies (for example, students referring to downtown, playground, vacations, in the car, library, beach, riding horses, etc.), EL students responded with more strategies for learning outside of school in the posttest (from 6% to 25%), while EP students made similar growth on this variable (from 0% to 27%, p=.008). The frequency of student posttest responses identifying learning strategies from both in and outside of school went up similarly for both groups, with only 13% of ELs reporting both on the pretest and 44% reporting both on the posttest, and with 19% of EP students reporting both on the pretest and 50% reporting both on the posttest (p=.039). These results show how the groups viewed school and outside of school contexts differently when initially considering how people need to learn new words, but that after engaging in collaborative inquiry into their theories, both groups similarly incorporated both contexts and considered multiple domains in their theories.

There were some discernable differences between EL and EP groups for the question of *what it means to know a word*. One difference was in how frequently students made reference to strategies they tested in their inquiry research. The EP students more commonly referred to strategies they tested in their inquiry research in their posttest responses to this question (73%) compared to the EL students (who did so in 25% of responses). However, both groups were more or less comparable in the frequency of explicit references they made to their Web of Inquiry projects themselves, with EPs mentioning them in 15% and ELs mentioning them in 25% of posttest responses. While EL students may have less often included the strategies tested in their inquiry in their responses to this question, they clearly understood these strategies as ways for learning words, as 69% of EL posttest responses were coded as aligning with learning strategies tested in their inquiry projects for question three (how do people learn new words), they just did not volunteer them as frequently in their theories in response to what they believed it means to know a word.

Lastly, as was the case with both the experimental and comparison groups, EL students demonstrated in their pretest responses to this question that it was a challenging question to understand and answer. In the whole experimental group, we found that students were more capable in contemplating and expressing their beliefs about the nature of word knowledge and what constitutes it after having engaged in collaborative inquiry into their theories of word-learning. While the entire group showed improvement in understanding and appropriately answering question four, with 55% on the pretest compared to 86% on the posttest doing so, there was an even greater difference in the EL group. In comparing EP and EL students, 65% of the EP students on the pretest gave answers demonstrating understanding of the question and capabilities in articulating beliefs in response to it, while only 38% of EL students did so. In the posttest, EL students made great gains in understanding and articulating their epistemological beliefs, with 88% of ELs doing so ($p=.021$), closing the gap with a similar ending performance capability as the EP students' 85%. This is particularly remarkable given that these students were undertaking an incredibly challenging and sophisticated conceptual task and successfully expressed complex knowledge, ideas, and beliefs in their second language, and did so as successfully as native English or otherwise designated EP speakers. ELs articulated such knowledge in their posttest responses by saying, for instance, "By using a word in a project. You can use it in talking and playing and different things," and "It means to know what it means, know how to talk with it, and what to say with it."

Metacognition about word learning: An emergent taxonomy. Lastly, I constructed a taxonomy of students' metacognition about word learning based on a qualitative analysis of students' open-ended responses to agree-disagree statement and scenario questions from the experimental group, with the aim of studying students' metacognitive understanding of how to manage different strategies for learning words and concepts. Emergent categories in this taxonomy include students' metacognitive awareness of how people learn new words, when and why people learn new words, and awareness of what it means to know a word.

Responses indicated that students recognized that there are different ways of learning that are useful in different contexts, with word learning being situated in the context of use, since, as Clara said in one of her responses, "each way helps you differently." For instance, when asked to take a stance about whether learning words is something mostly done in school, rather than outside of school, Rose disagreed, noting, "You can learn them both ways," and when asked whether thinking about the type of words is important in choosing a learning strategy, Pablo gave an example of how a situation or context is important to take into account, explaining how "If you are going to learn beach animal words you would not want to go to the forest to learn them, you want to go to the beach." Meanwhile, Rose's response to this same question indicated that this is a choice, saying, "You don't have to, but you can." Some students' responses to these questions revealed an epistemological view of knowing a word that included putting the word to use, as Angélica, an EL, demonstrated when she wrote that, "You can think first what it means, then you can use it." Efrain, also an EL, responded to this question by explaining the multiple strategies at work in his process for problem-solving unknown words, writing, "So you first think what it means, then try to picture it, and then look it up in the dictionary and see if you were close." In response to a later item, Efrain was explicit in expressing his belief in multiple learning strategies when he agreed with the idea that there are different ways to learn new words depending on what you are learning them for, writing that "I agree with Sara [referring to the student in the scenario] because I think there might be different ways to learn new words."

These responses show that students have an awareness that people can and should choose strategies for learning words, and that this should be done based on learning goals and purposes. Furthermore, students also acknowledged that learning strategies might be selected and applied sequentially. For example, one student proposed that it is best to first attempt to resolve the meaning of an unknown word using context clues, and then use a dictionary only if necessary, offering an efficiency argument for using strategies strategically since the dictionary strategy "takes too much time." Students also responded in ways showing that they believed that multiple strategies may be used to learn new words, as Janey expressed in her responses to two different items, writing that "you can learn a word with each of those choices and each will help you learn a word," and that "Both ways are helpful for learning a word. I will try both and that way I will know more." Other students wrote that, "a group project to see the words in action is great, but flashcards work OK. I'd suggest to use both theories because you'd learn the words better but it may take more time," and that there are "thousands of different ways to learn new words and some of those ways might work better with different words."

One last theme in student responses to Likert items included expressing a sociocognitive stance towards how people learn words, while listening and putting words to use in conversation. While it was common for students to suggest "asking someone" if they didn't know what a word meant, students went on to include more nuanced and sophisticated understandings of how communicating about words with others can help you learn. For instance, one student, Farima, explained how communicating is helpful, "Because you can share perspectives and talk about the words." Another student, Adriana, pointed to the importance of social contexts for learning new words since that is often how one encounters a word, explaining that, "You couldn't understand a word well without hearing it or seeing it used because that limits a lot of ways you could learn it." Ella also argues this point by simply stating that it is in conversations where you learn words, "Because you can learn words from listening to people talk," and Rose also voices the important role putting words to use in conversation can have in helping you learn when she says that, "I think if you learn the words, then talk about them, it keeps them in your mind." Finally, students in their responses showed their growing recognition of how they can learn words by using them in conversation, often with their peers or friends, as Adriana expressed in her response that you learn words when "talking with a friend," and which Ernesto, an EL, indicated as well, writing, "In class say those words, like you and a friend say *intelligent*, you don't know what it means and in the end you do because you said it to your friends." Meggie's response showed a view that you can learn more by using a word in your own conversations, saying, "If you talk about it you may learn more!" a view shared by Gabe in his response that, "I think if you talk more about the words it would be better."

Student responses also demonstrated metacognitive awareness of when and why people learn words. For example, students indicated an awareness of there being multiple situations for learning words, such as when Rose wrote, "Sometimes you could find them when you're doing this or that," and when Leilani wrote that people need to learn new words "To get a good job, to understand something, to be able to learn something, to find out things that are important in life, to understand things in times that are needed." Students also demonstrated an awareness of the importance of evaluating contexts for word learning in order to select and apply appropriate learning strategies, as when Gabe wrote that when choosing ways to learn, "It depends on what kind of word, because there might be better words to learn on a field trip or making flash cards, might have a group," and when Adriana wrote that "When you go on a field trip, that would be good for writing a story because you could see it, then in your story you could describe it the way you saw it. Looking in the dictionary would be good for a quiz, or a science project, etc. because the dictionary has many meanings you might need." Furthermore, students recognized the need to focus on learning goals in addition to purposes for learning in choosing strategies, as when Rose wrote, "If I needed to learn a word for a spelling test I would probably look it up in the dictionary," and which is also apparent in the response below:

> I think that it would be good to learn the definition even if it's not needed on the test. Like what if you had to write sentences? How many words will you have to study? What's the difficulty of the words? How long will you have to prepare?

Finally, students also demonstrated metacognitive awareness of what it means to know a word and of the relevance of considering this when choosing learning strategies. Students' responses indicated not only a metalinguistic awareness of words, but that one should notice and consider different types of words in considering strategies for learning words. For instance, Clara reflected that "Sometimes words could be hard or easy," as did Ella, writing, "there are harder words that don't have an easy definition," while Cole pointed out that "the word can have different meanings." Some students reflected on how, for some words, it was more difficult finding a definition, as when Rose explained that, "some words might have harder ways to find definitions and some easier," and that, "different words have different ways to find the words." Still other students said when choosing a strategy to use to learn, "you really need first to see what type of word it is and what it means," that, "It really does matter what the word is because if you went on a field trip and your word is "the," you can't see that in action," and that, "Some strategies depend on the word. Some words may be better on a field trip or on other things. For example: 'horse' you would find better looking on the Internet."

Still other student responses suggested that knowledge of words is demonstrated in the context of word use and measured by the ability to use words. For example, Adriana wrote that you show you know a word "When you are getting a job, for a report, for schoolwork, when you try something new," and gave as an example, "For rock climbing you need to know: tension, repel, figure eight, etc…" Adriana even went so far as to write that learning new words entails "trying something new." Gage described this idea of knowing words by putting them to use by explaining, "the more you use a word, the better you get to know them, and the word gets stuck in your head." Ella described the relationship of learning and using words across school and home, sharing how, "sometimes I learn a word and then I use it outside of school," and Pablo eluded to how they had learned the language of inquiry through the context of use, as a community of learners, when he wrote, "I think we would not use the words we do now unless we did Web of Inquiry." Other ways of knowing involving putting words to use also revealed the incremental nature of word knowledge, such as in being able to write a word in a sentence, use a word in a project, know more than just the word's definition, know the word "by heart," to "know it but you don't know what it means," and to use a word in "talking and playing and different things."

Finally, in thinking of what it means to know a word, students also considered what words are related to, as well as what other words are connected to it, which suggests awareness that the process of building associative networks or schemas for words constitutes word knowledge as well. For instance, Juan, an EL, explained that "it helps to picture it," while Gabe, also an English Leaner, wrote that, "When you *know* a word you can give an example, and you can give a definition(s), and you can see it in your mind." Adriana wrote that "Knowing a word, you can describe it, use it in a sentence, you know the meaning, give other words like it, and draw it," explaining in a different response that, "For me, experiencing a word gives me more words that describe it to picture in my head." Meanwhile, Janey wrote that, "to know a word is when you know all the concepts and things that relate to the word, and you have to know the definition, you can picture it," and went on to explain how "if someone explains or shows you how to do it, then you can sort of get a picture of what the word means." In this category, students showed an awareness of the depth and multidimensional nature of word knowledge, or as Ella puts it, "knowing a word is sometimes the same as knowing what it means. And I think knowing a word is sometimes more than knowing what it means." Pablo captures this when he says that, "You have to know everything about a word to really know it," reflecting that, "I can know a word's definition and not know how to use it. It is more than knowing its definition." He goes on in another item response to suggest what he believes makes up *really* knowing a word, including being able to "give many definitions, you can use it, you can pronounce it, recognize it being used, picture it, hearing it." Finally, Adriana proposed how thinking more about what it means to know a word can motivate you to learn more about a word as well, suggesting that, "If you are given a chance to learn new words, you might just learn the spelling. But if you think about what it means to know a word then you probably will learn the definition."

III. Analysis of Classroom Discourse Captured within the Video Corpus

In Section A that follows, I begin by presenting an analysis of video units and their relation to the results of students' learning shown in findings from the Word Learning Theories Assessments. This analysis is intended to corroborate those findings, and to discover how discussions shaped students' understandings of word learning. To that end, I also present an analysis of emergent codes within students' collaborative knowledge-building, to extend understanding of students' ideas beyond those which were predominant in the Word Learning Theories Assessment data. *This analysis provides a detailed picture of students' understandings of how they learn, and the breadth and depth of ideas that developed collaboratively over the course of students' learning* within conversations that took place in the instructional environment.

Following this initial video analysis, I present in Section B findings from a detailed analysis of a small sample of video exemplars chosen using purposeful sampling. These units included discourse in which learning how to learn or how to improve one's learning were made explicit as topics or ideas introduced, developed, or otherwise discussed. As such, these exemplars provided data sources that could be analyzed with the goal of *identifying discourse practices and processes entailed in the collaborative development of ideas, including those related to the growth of students' metacognitive capabilities in word learning*. In addition, I endeavored to characterize and understand how the teacher supported students' metacognitive development.

A. Video analysis of the content of classroom discussions about word learning. Quantitative and qualitative analyses of the Word Learning Theories Assessment provide evidence of ways in which students' theories for word learning became more coherent over the course of their participation in the curriculum, and show how students develop metacognitive capabilities as learners. To better understand how such results were achieved, I analyzed the entire corpus of video discussions to see how ideas about learning emerged in classroom discussions among students themselves and with the teacher. I began by coding each video unit for predetermined categories, paying particular attention to those from the assessment that showed a significant main effect for students in the whole class as well as for the EL subgroup. I also coded for categories developed in constructing the Taxonomy of Metacognition in Word Learning. Finally, I coded discussions for emergent categories related to students' thinking about word learning. Analysis of video units in which participants engage in the collaborative development of ideas extends our understanding of learning to include not only which ideas were discussed in such a context, but the processes by which particular ideas important to the curriculum were

(a) introduced into discussions, (b) how they were pursued, or developed within the community, and (c) ways they were appropriated, taken up, and put to use by students. To capture these processes I developed emergent codes that were organized around the four questions: *why do people learn new words, when do people need to learn new words, how do people learn new words*, and *what it means to know a word*, since these were core questions guiding students' inquiry in the curriculum. Coding results reveal frequencies of topics discussed and characteristics of discussions taking place over time.

Why people learn new words. In Table 19 below, I present frequencies of occurrences in discussions for categories related to why people learn new words. Categories derived from the Word Learning Theories Assessment and Metacognitive Taxonomy are shown in the top of the table, followed by emergent categories. For each, I report frequency results in descending order, beginning with categories that were most frequent in video unit discussions.

TABLE 19
Video Discussion Units Related to Why People Learn New Words

Assessment Categories that Showed Changes	Frequency in Video Units
Why do people learn new words?	
To communicate	12
For a job or profession	9
Situated, Context of Use	7
Sociocognitive, social purpose	6
To understand others	4
To learn meanings	3
Metacognition Taxonomy	
Purpose for learning is dependent on learning goals	4
Emergent Ideas Coded for in Video Unit Discussions	**Frequency in Video Units**
To learn, understand something	11
To learn/understand a new language	7
For school work	7
Affective purpose (for fun, excitement)	6
To understand different life experiences	6
To become a better learner	6
For both in and outside of school contexts	5
For going to new places, travel	5
To develop a language of practice	5
To communicate a medical need, emergencies	4
To go to college, do well in school	4
To describe or explain experiences, ideas	4
To help someone understand something	4
To read	3
To become part of a community, connect, bond	3
To develop as a writer	3
To understand or use technology, language of technology	1
For a test	1

Total Video Units, n=145

Communication. Communication was the most frequent of all of the categories identified in discussions (12 units were coded) about the purpose for people learning new words. This confirmed patterns of results for the first question of the Word Learning Theories Assessment. For example, Lucero (an EL), in the beginning lessons of the unit, when the class brainstormed theories, offered a theory that people learn new words from friends who speak a different dialect of a language or a different language. Lucero described a situation when she needed to learn new words in Spanish to communicate with her friend who spoke a different dialect of Spanish than she did. The idea that people learn new words in order to learn or understand a new or different language was also a more frequently voiced idea in discussions, coded in 7 of the video units (see emergent codes).

For a job or profession. Learning new words for a job or profession was the second most frequently discussed reason (under the assessment categories) for why people learn new words, found in nine units. Students suggested that learning new words is important for a wide variety of professions, including teaching, construction, accounting, hair styling, babysitting, and medicine. Students also recognized the importance of knowing words in order to be hired for a job, for instance in order to understand words used by a potential employer during a job interview, as Lena explained:

> Maybe you speak Spanish and you want to get a job, and there's this boss, or the manager, says I can't understand a thing you say, so you try to think of words…[to get a job] you learn language.

Students also discussed the need to acquire new technical vocabulary in the workplace in order to be successful, as Emilio (an EL and Special Education student with language delays) described, "You need to know words, you start with [the] words and you go to a job, like 51-50, you need to learn the words to do your job, to keep your job." Here he gives "51-50" (which is a code or label used by police to refer to someone being an endangerment to themselves and others[5]) as an example of terminology needed to learn to perform one's job well and keep it.

Situation, context of use. Another category found in seven units relates to the notion that people learn new words within the context of their use. Some examples from the video include Aaron's idea that you encounter new words in your life, "like when you're going to see lots of words just like around…like if you were walking downtown you might be able to use some of those words, on signs," as well as Robin's idea that when you are listening to a conversation your parents are having, trying to understand it, you learn new words by asking what certain words mean, or Omar's idea that you might have to learn new words if you need to understand what your teacher is saying if you are trying to learn in school.

Social purpose. Learning words for a social purpose within social interaction was present in six units. Students offered a number of diverse reasons why people learn words that involved a social purpose for learning. Some of these included understanding a question someone asks you, understanding each other when you are having a conversation, in performing a job when a colleague explains words to you, or you ask what something means. Other ideas brought up included to help someone understand something, to teach, to understand a family member, to understand someone or a family member who speaks a different language, and Eddie's idea that you learn new words "to connect," not just to understand each other, but to bond.

[5] According to Urbandictionary.com

Examples of this included having a language you use that shows you are close friends, for instance words related to a shared hobby, like playing hockey, drumming, or yo-yoing, or even a special lingo with a group of friends, like a made-up language. In another example Flora shared from a book she was reading, a girl traveling in another country gets lost and doesn't know the language. Flora explained people need to learn new words to be able to communicate in an emergency, as this girl needed to learn new words so she could find her parents, to understand other people who could help her, to ask directions, and so on.

For meeting learning goals. I also coded video units for whether or not ideas were brought up which explicitly articulated that the purpose for learning words is dependent on one's learning goals. Although this category was only found in four units, it is noteworthy as such ideas demonstrate sophisticated metacognitive awareness about learning processes. One took place during the initial class brainstorm, two occurred while students were analyzing data, and one happened during the step requiring students to coordinate their theories with evidence in forming their 'current best theory.'

Examples from these units include students identifying not only reasons why people learn new words, but reasons why people should learn how to learn new words, including that successful learning strategies would be useful to know "so people can learn more," and "to learn *better*." In another example, a student questioned how it is possible to learn and know a word, but then forget it quickly.

This led to a theory based on students' experience conducting their investigation that some strategies are helpful for short-term learning goals while others are helpful for long-term learning goals. The class went on to talk about what their goals for learning new science words in school should be. Guided by their self-assessment rubric, students deliberated about what their goal for learning new words in science should be, whether they should be to be able to use examples, give a definition, or to be able to explain how it's related to other words and concepts. While entertaining this question was itself challenging, bringing up notions of the incremental nature of word knowledge, the teacher connected the idea back to a student's earlier observation that the levels of their rubric were "like life," representing their own language development over the course of their lives, and their lifelong goals. This discussion ended with recognizing that while it is not always possible to learn things really well over a long time, it's a good goal.

Emergent ideas coded in the video units extend our understanding of students' learning and participation in the curriculum beyond limitations presented by forming responses to the four open-ended questions of the Word Learning Theories Assessment. Some of the emergent categories help to illuminate a deeper understanding of the predetermined categories themselves.

For learning or understanding. For example, the most frequent emergent category coded was that people learn new words in order to learn or to understand something, present in eleven units. This was almost as frequent as the predetermined category with the highest frequency, *to communicate*. The category, to learn, suggests a greater purpose for learning words that entails many of the reasons also found in data from the predetermined categories. For instance, learning involves communication, is often required in a job or professional setting, and learning meanings of words specifically is but one of the multiple aspects of word knowledge.

For understanding a new language. The second most frequent emergent category for why people learn new words was to learn or to understand a new language, present in seven of units. While understanding others was not a predetermined category that showed patterns of change for the class as a whole, it was one in which EL students showed growth. This more specific and frequent emergent category helps illuminate that learning new words for the explicit purpose of learning or understanding a new or different language was indeed an important idea voiced in multiple discussions within the curriculum.

Almost all of the units coded for learning a new language occurred during the brainstorming sessions at the beginning of the curriculum, with students suggesting that people learn new words to communicate with friends who speak different languages or dialects, to communicate in a job interview when you speak a different language and are trying to understand a question or communicate an answer, or as Estella suggested, “if you go to different places, like cities in Mexico, and you only know English and they speak Spanish, and your family wants to go to Mexico, you learn from different people.” Students shared their own experiences learning new words for the purposes of learning a new language in order to understand their own family members or what people are saying in a new place, for instance when traveling to a new country and not knowing or understanding the language spoken there.

In one such discussion, students went on to consider why people learn multiple languages, the benefits of bilingualism, spurred by Jesus' comment that "if you know two languages you get extra credit," and ways of communicating across two languages. Emiliano, for example, suggested that combining Spanish with English words, substituting words in English for unknown words in Spanish, could help you communicate across languages. Estella and the teacher further discussed the purpose of learning a new word in another language:

> Estella: "In [Mexico] people who didn't know English, he [my cousin] spoke to me in Spanish, and my brother, he was speaking English for the first time. When I went to Mexico my cousin didn't know that much English, now she knows a little.
>
> Teacher: "Maybe we're not just learning new words to understand family, [but to] to help each other, you can communicate and help each other learn new languages."

In this discussion, Emiliano went on to describe a computer program that translates words from English or Spanish. A week later, a monolingual English speaker brought up the idea that people learn new words by learning across two languages, attaching a new label in a second language to a known concept and word in their first language:

> Maybe they speak Spanish and they want to learn to speak English and they go to a bilingual class, say the word in Spanish and then they say the word in English and they get them to say the word in Spanish and English and then they know what the word in Spanish means, or in English means.

Developing a language of practice. This category helps to unpack predetermined categories of learning being situated in the context of its use and in social situations. In Eddie's example earlier, he expressed "to connect" as a purpose for learning words, with other students contributing that the purpose of learning words is not just to understand each other, but to "bond," using words that indicate affinity and shared participation within a community, such as in a club, team, or other type of organization. Developing a language of practice is often a characteristic of the processes entailed in situated learning and learning within social interaction. Another example from the brainstorming session in the beginning of the curriculum shows how a student. Lena, builds on another student's idea to show how understanding words can signify membership in a group, and how this led to the students meta-analysis of their own development of a language of practice around scientific inquiry:

> Lena: "Like what Silvie said, might be trying to, if I were in a group of girls and we were talking about something in science, an experiment, and I didn't understand something and felt left out, they would try to explain it."
>
> Teacher: "It's not just about understanding an idea, like in science, it's about feeling like you are part of a group, knowing certain words can make you feel like you are part of a group."

Other emergent reasons for why people learn new words were more self-explanatory, such as for schoolwork (7 units), for going to new places or while traveling (5 units), to do well in school or to go to college (4 units), and to read (3 units). Along with these perhaps more mundane reasons were some others that were surprisingly unique, such as that a purpose of learning words is for affective reasons, such as having fun or passing time (6 units), as Ava describes in her example of how she decided to learn new words as a way to entertain herself when she broke her arm. Another unique category was that people learn new words in order to understand different life experiences (6 units), an idea which came up when students were talking about traveling to different places and learning from others with different experiences and languages in groups, as Adam articulated saying, "kind of like life situations, going places, to learn about different things."

Metacognitive awareness and capabilities. Finally, some of the emergent categories for why people learn new words were more germane to the central learning goals of creating a learning environment where students develop metacognitive capabilities while conducting collaborative inquiry into their own theories for learning. One such category that emerged was the idea that people learn new words in order to become a better learner (6 units). As in the predetermined category from the metacognition taxonomy (the purpose for learning words being dependent on one's learning goals), students engaged in discussions in which they identified becoming a more expert learner as a goal for why people learn new words. In addition to seeing how knowledge of effective learning strategies can be beneficial for the goal of learning more or " to learn *better*," students became aware of how understanding how you learn can potentially help you learn better, noticing for instance that they were starting to pay more attention to words while learning them, and developing a more word conscious disposition, as Adam explains: "I noticed, came across words we studied for this, some of the ones that are more uncommon, like interdependence."

Students also participated in discussions about why people learn new words that included both in school and outside of school contexts (5 units). This frequency in units is particularly revealing since students on the Word Learning Theories Assessment readily identified school as a context for learning new words on the pretest (50%), but did not show the same results for learning in community or outside of school contexts on the pretest (2%).

When people need to learn new words. In video data, I found many units that mirrored categories from the Word Learning Theories Assessment regarding students' thoughts about when they need to learn new words (see Table 20 below).

TABLE 20
Video Discussion Units Related to When People Need to Learn New Words

Assessment Categories that Showed Changes	Frequency in Video Units
When do people learn need to learn new words?	
In School	11
Community (clubs, soccer, downtown, etc.)	11
In conversation, talking to someone	9
Situated, context of use	7
Sociocognitive, social purpose	6
Experiential learning (museum, field trip)	5
Traveling, vacation	5
Anticipating specific situations	5
Word Learning as Incidental	5
In *and* Outside of school	4
When reading	4
Metacognition in identifying situations	3
Metacognition Taxonomy	
Evaluates types of learning contexts, goal-driven need for word learning	6
Emergent Ideas Coded for in Video Unit Discussions	**Frequency in Video Units**
Learning new language	7
In a job, profession	6
In an emergency	5
Developmentally, when young people are learning to talk	3
Understanding family members who speak a different language, immigrating	2
Aligns with word learning literature	2

Total Video Units, n=145

Learning new words in school. Many students began the curriculum with the idea that people need to learn new words when they are in school, especially ELs, as previously reported. The idea was also the one most frequently present in discussions about when people need to learn new words, found in 11 units. Students gave numerous examples of when they may need to learn new words in school. For instance, Ruby suggested that it is important for students to learn new words when they are studying or preparing for a test, in order “to understand questions on a test.” Other situations students included when they are called on by a teacher, during a time when a teacher or student is reading aloud in class, for a vocabulary test, while learning in content areas such as math or science, and in developing a language of practice in a learning community, such as they were doing in their work with the Web of Inquiry.

Learning new words outside of school. Equally frequent in discussions about when people need to learn new words was the idea that people need to learn new words in situations involving being—or becoming—part of a community outside of school. As with school, the idea of needing to learn new words as a part of a community outside of school was also found in 11 units. Students described needing new words in situations like participating in a club (like a chess club), or a team (like in soccer), at a store, when signing a contract, reporting an emergency, walking down the street reading signs, going to an airport, on the bus, at camp, during music lessons, in the neighborhood, when buying a car, and as one student put it, “out in the world.”

Learning words in a context of use. Seven of the video units involved discussions pertaining to needing to learn new words in situations where the words are being used for a particular purpose, situated in a context of use. Many of the examples of situated word learning were also examples from learning within a community or in one’s daily life, apart from school contexts. Some situated word-learning examples students described included learning words while learning a new skill, learning to play a game or instrument, being on a team like in soccer, learning during a field trip or at a museum, when buying something, when you have an injury or medical need, when learning a new job, or while at the dentist.

Learning for communicating with others. The need for people to learn new words when they are talking to someone or having a conversation was present in nine of units. Other categories of ideas students brought up for when people need to learn new words included situations involving social interaction (6 units), during an experiential learning situation (5 units), such as when on a field trip or visiting a museum), when traveling (5 units), and when reading (4 units). All of these categories showed patterns consistent with the Word Learning Theories Assessment results.

In and outside of school contexts. Just as for situated learning, there were other predetermined categories that coded for characteristics of ideas present in discussions rather than coding the content of ideas. One such category was whether discussions included *both* in *and* outside of school contexts (as opposed to either in school or outside of school only, each which was coded for separately). In this category, units were coded if during the video unit both school and outside of school settings were referred to, as was the case for four video units.

Incidental learning situations. Five video units were coded as including situations of incidental word learning. Examples of incidental word learning students gave included people needing to learn new words while encountering them while watching TV, going out in the world, on the bus, in a store, in conversation, and while listening to conversations their parents were having.

Anticipating situations for learning words. In five video units, students demonstrated metacognition while considering situations when learning words is useful or necessary in *anticipation* of a situation or event (5 units). Anticipating a need involves metacognitive capabilities such as planning and reflecting on when a particular skill, capability, or process might be useful in achieving a goal. One example included the more common idea that you would need to learn new words for a test, studying them before hand so you could do well on the test. This came up in the context of spelling tests or tests about vocabulary words; however, Coral introduced the new idea of it being useful to study words in order to understand questions on a test. Other more uncommon ideas included Sarah's idea that, "When you're children, you're learning language so when you're grown up you can communicate," and Emma's idea that you need to learn technical vocabulary for a job *before* you perform it, such as "When you work in an airport and the pilot or someone needs to know [something]." Other examples included knowing certain words in advance that be helpful for an emergency, like *defibrillator,* and certain code words used by police to respond to a crime or that are used in schools to signal to teachers, staff, and students to begin lockdown procedures in an emergency. One example which resonated with many students in the class was the idea that one might learn a new language before traveling to a different country where that language is spoken, or if you were to have a guest come from another country who might speak a different language, you might want to learn words in that language before they arrive:

> Alicia: "If you have a cousin from another country coming to visit, try learning words in that language."
>
> Teacher: "To communicate with family, family visit…"
>
> Eduardo: "Family talk."
>
> Teacher: "For a guest."
>
> Justine: "If someone moves here, they need to learn here, to communicate with the kids here."

Learning across languages. Students' demonstrations of metacognitive capabilities in identifying learning situations for *when* people need to learn new words were present in three units. In all of these units, there was a clear theme that students learn across two languages. This category shares examples with the previous category, identifying when it would be useful to learn new words in anticipation of a situation or event, such as learning words in a new language to prepare for a trip or before a guest or family member who speaks a different language arrives for a visit. Another example from this category includes Lettie's reflection on how she learned across her two languages from a friend who spoke a different dialect of Spanish, explaining, "I have this friend and she speaks … a different Spanish... You could learn new words from friends, from other kids from around the world." A third example involved metacognitive awareness of how language learning can help achieve broader goals, such as being successful in school.

Metacognitive strategies for learning words. The final predetermined category for coding video units was from the taxonomy of metacognition about word learning, and involved students identifying multiple situations for learning and critically evaluating types of learning contexts. In doing so, students recognize different learning goals, and see a goal-driven need or purpose for word learning. This category was present in six of the video units. Students recognized that people need to learn new words in a variety of diverse contexts, like in Adam's response, "most important is we're going to see lots of words just by going out….like if you were walking downtown maybe you'd be able to use some of those words." Other examples of students showing an awareness of multiple situations when learning new words might be valuable in achieving a goal included in preparing for a test, and entertaining yourself as a pastime when you are laid up with an injury, and trying to communicate in order to make a correct purchase or solve a problem.

In other examples in the video, students theorized about how going out and looking for evidence of what words mean might be more appropriate for learning certain kinds of words, such as those in science. Students also considered different strategies they tested for learning words in science and contemplated whether they would be effective for other learning goals. For instance, students considered whether learning with flashcards might be a more useful or appropriate learning strategy for preparing for a trip to a different country, since they can be used to quickly learn new words before going. Another idea was that learning words experientially, for example by going to a museum, allows you to learn about words in more depth which might be more useful for learning a few words really well, and which may help one understand the words better or remember them for longer, but that this may not be the best strategy to choose if you have less time, such as if preparing for a trip.

The most frequent emergent category identified learning a new language as a situation when people need to learn new words. This category was present in seven of the video units, a fairly high frequency. This is not surprising given the population of EL students, since learning a new language is a part of their daily-lived experience, particularly if they were in bilingual classes prior to the fourth grade. This category also exemplifies ways in which inviting students to theorize about their own language learning allows for linguistic funds of knowledge and experiences of culturally and linguistically diverse students to influence the ideas of the entire learning community.

Other emergent categories for when people need to learn new words included for a job or profession (6 units). This was also a predominant category for why people learn new words, both in frequencies of video units (with 9 units) and in the pre-post data from the Word Learning Theories Assessment. Some ideas brought up in discussions of situations when people need to learn new words for a job included police learning code words and airline pilots communicating while landing planes. Other examples from discussions included doctors, dentists, and lawyers, who need to learn technical vocabulary specific to their field, as well as a discussion of the term "legalese," words so technical, they have their own name to describe it.

Another emergent category for when people need to learn new words included in an emergency, with 5 video units coded. Emergencies as a context for learning or knowing new words was a common topic of discussion, and was also present in multiple video coding categories for *why* people learn new words, including in the predetermined category for social interaction, and as an emergent category. For when people need to learn new words, emergencies came up as examples for the predetermined category learning new words in communities outside of school, as well as in examples of anticipating situations when learning new words might be necessary, such as in order to communicate a medical need in an emergency (4 units).

Finally, emergent categories with lower frequencies in units, but which are interesting include when growing up such as when one first learns to talk (3 units), and when one needs to understand family members who speak a different language, such as after immigrating (2 units). A last emergent category included coding units for the presence of ideas relevant to the word learning research literature (2 units). These included discussions in which the teacher made connections between students' questions or ideas and research, such as discussing the number of words children learn each year they progress in school, as well as how learning to talk is one of the most cognitively complex processes one learns, followed by reading.

How people learn new words. In developing a research design as a class that was feasible, students chose a limited set of learning strategies that aligned with—and tested—particular theories for learning. As the class proceeded with their inquiry and focused on research questions about how people learn new words in science, whole class and small groups' discussions were focused on theories, ideas, and strategies regarding how people learn new words. Thus, as Table 21 below shows, frequencies were highest for both predetermined and emergent codes for *how people learn new words*, as this was at the core of students' research.

TABLE 21
Video Discussion Units Related to How People Learn New Words

Assessment Categories that Showed Changes	Frequency in Video Units
How do people learn new words?	
Field trip	69
From context while reading	63
Using flashcards	58
Experientially	57
Situated, in context of use	31
Aligns with word learning literature	29
In school, schoolwork	29
In *and* outside of school	28
Multiple strategies for learning	25
In community context	21
Word Learning as incidental	15
Metacognition Taxonomy	
Sociocognitive theory for learning words	
Strategic in applying theories for different contexts	40
	47

Patterns in Emergent Ideas Coded for in Video Unit Discussions	Frequency in Video Units
How People Learn Words	
Awareness of word learning processes, evaluating strategies	81
Developing self-efficacy as word learner (word consciousness and usefulness of learning theories and word knowledge)	55
Metalinguistic awareness in learning words	53
Learning from a more knowledgeable, expert-other	44
Through social interaction (e.g., asking someone, conversation)	44
Dictionary	36
Depends on the text, considerations in text	33
Strategies for problem-solving unknown words	32
Conducting research, investigate	25
Having to do with motivation for learning	23
From family	17
Computers, technology	16
Memorize, study, practice	12
While writing	12
Learning across two languages	11
Through 3rd party participation	10
Developmentally as you grow older	10

Patterns in Emergent Ideas Coded for in Video Unit Discussions	Frequency in Video Units
Exposure to words, quantity of words	8
Multiple exposures to words	7
Depends on the person	7
Using pictures, picturing	7
Making connections to things you already know	5
From friends, classmates	5
Learning a new skill, game	5
On the job, in a profession	4
By yourself	4
Through legitimate peripheral participation	3
During a medical need	2
Reading with a sibling	1

Video Units, n=145

The highest frequency among predetermined codes was 69 units (going on a field trip), while the highest frequency for emergent codes was 81 units (showing an awareness of word learning processes, evaluating strategies). Frequencies of predetermined codes in video units for the most part align with results from the Word Learning Theories Assessment presented in Table 16.

As one might expect, students most frequently discussed the learning strategies and approaches they tested in their research. Going on field trips, reading, and making and using flash cards as ways to learn new words were the most frequently discussed predetermined categories. Field trips as a way of learning new words (which they determined from their research was most effective), was the most frequent of all the predetermined categories. Discussions of reading as a way to learn new words were present in 63 of the video units, and flash cards were present in 58 units. Coding of discussions where the idea of learning new words experientially were also frequent, found in 57 units. These four categories, ranging from 57 to 69 units, stand out with the highest frequencies across all categories, and were present in almost half of the total number of units (145). Their frequencies were considerably greater than the other predetermined categories, which ranged from 15 to 47 units, showing a great number of discussions were about these strategies.

Learning based on field trips. While discussions of field trips as a way for people to learn new words were most frequent, found in 48% of all units, the contexts in which field trips were discussed varied. Early on in the curriculum, students suggested going on a field trip as a way for learning new words and theorized about why that might be a valuable way to learn new words in science. For example, Owen suggested on the second day of the unit that, "you could go to a special place, like if you want to go learn more about marine life, go to an aquarium, or about flowers, to an arboretum." Another recurring way of describing this theory was as Ava put it, to "go to a place where we can see it in action." In planning their inquiry as a class, they considered the value of learning experientially through field trips as well as the feasibility of going on a field trip for learning new words in science, as the following example illustrates:

> Teacher: "What are some things we could do?"
>
> Student: "Discover?"
>
> Teacher: "Is that realistic Jeraldo? The words would have to be something we could find locally, we couldn't study a tropical rainforest…"
>
> Jess: "We could find local words at Ocean Side market."
>
> Teacher: "We could find some things that we could go see, like at the aquarium…"

> Students: “We could go to Hidden Lagoon, study the environment…”
>
> Teacher: “OK, we could go to Hidden Lagoon, OK…”
>
> Cole: “I found a raccoon there hunting fish once.”
>
> Teacher: “What is that theory of learning, we go to Hidden Lagoon and what?”
>
> Jess: When you see it, you discover how the animal does its habitat, and how it gets its food, and makes its nest and its home.”
>
> Teacher: “So we go to an actual environment and we look for and discover firsthand, see it with our own eyes, experiencing it, seeing it in action.”

Later on, students discussed field trips while analyzing their data, looking at their data to coordinate theory and evidence while coming up with their Current Best Theories for how to learn new words in science. For example, when asked by the teacher what could be “our big take-away, as a class, for teachers, what can we learn from this?” a student replied “Field trips, for them to go and learn more by trying something, to maybe plan something with their families, field trips to learn new words.” Students also provided an explanation for their Current Best Theory, for example, articulating as one group did how “Field trips are the best way to see words in action, and feel it, and see how it describes the thing you are discovering.” In other cases, students simply mentioned field trips as part of a class discussion, for instance while reviewing strategies the class had chosen to pursue for their inquiry, variables they planned to manipulate, or which strategies were most successful given their data analysis and results, such as when Jane says “field trip and flash cards helped more than reading.”

Finally, students considered the implications of using field trips as a strategy for learning new words in science in a broader context, critically evaluating the usefulness of their Current Best Theory with respect to policy, school funding, and contemplated questions leading to new ideas for inquiry, such as how learning new words while on a field trip might depend on the grade level or subject area. Students did this by posing many questions that led to greater discussions, such as Ava's question, "If that is the best thing to do, does it mean they have to go on it, but then what if they can't go on them?" This led to a discussion of how the argument to be made is that going on field trips is valuable for learning new vocabulary, but also that it is especially important to focus on language as part of field trips, looking for evidence of concepts in action and attaching new words as labels to new concepts, with the recommendation that if teachers aren't already doing this, they should be.

Jadel's question, "Doesn't it depend on the field trip you go on, like Disneyland?" led to a discussion of how different destinations for field trips could support learning new vocabulary in many subjects and content areas in addition to science, such as in music. For instance, fourth and fifth grade students at Ocean Park Elementary attend a symphony field trip each year, and students discussed how an emphasis on the technical vocabulary and more "academic terms" or language of music might be supported by such a field trip. This example also led to a discussion of how what you can learn on a field trip depends on students' grade level, and that you could go to Disneyland to learn about many things, including characters, fairytales, space, physics, and the state of California, with the idea that by experiencing concepts one remembers them better.

A final illustration came from Ria's question "If the teacher or school couldn't afford the field trip, what if you can't afford it, can't do it?" This question led to a discussion of the policy recommendations the students' research supported and the actions they might take as a result. For instance, they considered how they might make recommendations to the School Board, City Council, and voters, and how their results might be useful in supporting the passage of taxes to help fund schools, or how they might lobby the School Board for funding for field trips by demonstrating through their research that they have evidence of the educational importance of field trips, but that not everyone can afford them. One example brought up was that their results might be used to support funding the four-day, residential Outdoor Science School environmental education program that 5th graders participate in.

Reading as a way to learn new words. Reading as a way to learn new words was present in 63 of the video units. Many of the students already began the inquiry curriculum with the idea that reading is an important way to learn new words, with 42% percent of students identifying reading as a way for people to learn new words on the Word Learning pretest. Reading as a learning theory for how to learn new words in science came up as one of the first ideas students offered in brainstorming sessions in year one early on in the curriculum. In response to the question 'If you were trying to teach someone words in science, how would you do it? What are ways to learn new words in science?' students answered, "by reading," and, "read a book." In response to the question "Where else can we do research," common responses included, "going to the library," and "looking in books." Students in year two also readily viewed reading as a way to learn new words. In addition to identifying reading as a context for word learning, students further developed and explained how reading served as a mechanism for learning new words. For instance, in year two Zane suggested that you learn new words when you "read different sentences with the words in them," and Edgar said that "When people are reading they learn new words… And you learn new words…because you're reading the book, not all the books are the same." Sam built on this idea by following with "You're reading a book and you find a word and you ask yourself, I really want to know what that means, go to the dictionary…" The example below shows a student describing the process of using context clues to problem solve the meaning of unknown words while reading:

> Lena: "When you're reading a book, let's say you're reading a Harry Potter book and there is a word I don't know and I read it over again and then I read ten words above it and if at the top it says kitchen and at the top it would say we made food, it was what it meant, an example…"
>
> Teacher: [referring to chart] "Can I put an arrow right here, when you're seeing a word you don't know, like her example kitchen, and it gives you examples, you're using the rest of what it says as clues, you're using what they call context clues or signal words, if you were reading something that said I love different kinds of fruit, apples, bananas, zipidip, what is zipidip?"
>
> Students [choral response]: "A Type of fruit!"

As students planned their investigation, reading came up frequently in the context of discussing their research design and detailed plans. For instance, students discussed reading as a strategy for learning words while making decisions about what texts they would read and how they would find text with the words they were studying. As was the case with each of the three strategies for learning new words students tested, reading often came up and was coded in discussions in which students reviewed the strategies they were testing, the variables they were manipulating, and their results, such as reviewing which of the strategies was most effective.

In analyzing their data and coming up with a Current Best Theory, as well as while considering alternative theories (particularly while completing the Web of Inquiry steps for coming up with *Other Theories, Limits of Our Theory, and Further Research),* many of the discussions about reading involved a critical analysis of why reading was the least effective of the three strategies. For example, when the teacher asked why reading produced the least growth for most students, as well as the lowest average score, and whether they should say reading is not a helpful or good strategy for learning vocabulary, Ava replied, “It could be different for somebody else.” Students questioned whether some learning strategies would need more time to be most effective, or more effective than others. The class theorized about whether in their research enough time was spent reading to test the strategy effectively, and whether it was a realistic goal to attempt to learn the number of words that the class decided to attempt to learn with each strategy. Students voiced that they probably could have done better had they read for longer, that this may have increased the scores. They also speculated that if each strategy had been used more than once, it might have made a difference in the results as well.

Students also pointed out that the class *did* make growth with reading, and that a few students made a lot of growth with this strategy, suggesting reading was effective; it just made less growth than the other two strategies. Additionally, Ruby pointed out that while “field trip and flash cards helped more than reading, reading might have been better compared to some other strategies.” Jose suggested it might be better than asking a parent, while Amber suggested it could be better than looking in a dictionary or asking a teacher, and Ava suggested it might be better than being given a word list and practicing, being given a test, or worksheet packets. In sum, much of the discussion around reading as a strategy involved considering alternative theories that could explain results, including that the conditions of the research design were not optimal for testing reading’s effectiveness as a strategy for learning new words.

Finally, a great deal of discussion explored issues related to the role the text itself plays in learning new words. As Ava noted, “for reading it might just be the text, it might not come back to the word, might not give the definition or the meaning.” This also led to a discussion about whether certain strategies are better for answering different kinds of questions on the posttests. Building on Amber’s idea that flash cards might be better for learning definitions, and Zane’s observation that field trips were more helpful for answering questions in which students represented word schematic knowledge through drawing examples and what words and their concepts were connected to, students considered whether reading might be better for answering certain questions and meeting particular learning goals. One student suggested reading might be better when used following a different strategy, such as a field trip. This suggestion also hinged on the idea that when a word or concept is brand-new, it might be more beneficial to introduce it experientially, and then use reading as a strategy to further explore or deepen understanding of the word.

Meanwhile, Ava introduced the idea that there were problems with the text itself, that it was "way too hard." In fact, discussions around considerations of the text were so prevalent, they were coded separately as an emergent category (reported in the following section). In these discussions students introduced and built on ideas that were critical of reading as a strategy for learning words due to issues related to text type, limitations of texts, difficulty of text, and problems in the text itself.

Making and using flashcards. Making and using flashcards, as a way to learn new words, was the third most frequent of the predetermined categories in units, present in 58 units. Though not one student suggested flashcards on the pretest as a way to learn new words, students volunteered the idea during class brainstorming sessions in the beginning of the curriculum. In both years, students suggested using flashcards as a strategy for studying or memorizing words before a test. For example, in year one a student suggested, "If a word is on a test, you can make flash cards to understand it." In year two the idea of flashcards came about from a larger discussion involving many students and scaffolding from the teacher.

> Elizabet: “Write them down, try to memorize them, then when it's time for the test, like if you're done, you could know them.”
>
> Teacher: “So you make a word list and a definition list and memorize them, repeat the word, definition, memorize them, make a list…”
>
> Alondra: “Sometimes you could use cards and write the word and write down what you don't know.”
>
> Teacher: “You could make flashcards, on one side put the word on the other side the definition, the meaning.”

Discussions of flashcards also involved how they might be used, with students saying for example, “you could practice yourself, or with someone else,” “you could say the definition, then turn it around and see if it was right,” and “You could work with a partner and have them test you.” Students also discussed what you need to know to make them, that “you learn how to spell the words, know how to master them, remember them, learn how to write them down,” and that, “There might be a word on the list you have to memorize [and] you don't know what the meaning is, you have to look it up.” Discussions included the idea that there are polysemous words, words with multiple meanings, and how very often with science words, you may know the everyday meaning, but not the precise scientific meaning of a word, requiring you to build your schematic knowledge for a word.

Flashcards were discussed when students considered learning strategies they were testing, variables they planned to change or measure, and which strategies were most effective. Students also weighed the usefulness of the flashcard strategy while coming up with their Current Best Theory. Students critically evaluated the flashcard strategy and it’s effectiveness in light of different learning goals, especially in thinking about how well one needed to know or understand a word. For instance, Jadel noted that, “Seeing in action is better because seeing them happen helps us understand better than just trying to memorize them… using a glossary to make flash cards is not as helpful as seeing in action, but still is helpful.”

In particular, students saw flashcards as an effective strategy for memorizing word meanings for tests or for learning many words quickly, such as in the case of preparing for a trip to a place where another language is spoken. In student discussions coded for flashcards, they also articulated the limitations of flashcards as a learning strategy for really *knowing* a word well. While analyzing their data, the observation was made that a lot of people on their assessments, following their use of the flashcard strategy, didn't write, "I don't know," but instead wrote more often "I know but I forgot." They also reflected on, questioned, and shared their experience with the flashcard strategy in whole class discussions which led to a theory that flashcards are helpful for learning what a word means for the short-term and that different learning strategies may be useful for different goals.

Experiential learning. Fifty-seven of the video units were coded for experiential learning as a way to learn new words. Units coded for experiential learning were often also coded for field trips as a way to learn words. However, it was possible to distinguish between whether students were identifying field trips as a context for learning, and whether they went on to articulated a theory for why such a context may be effective or useful for learning new words. In many of these units, students provided a theoretical argument or rationale for why such an approach is worthwhile, and they did so while engaged in multiple stages of the inquiry process, including while brainstorming theories for how people learn new words, as well as when choosing specific strategies to test, analyzing and interpreting results, and considering ways of applying their Current Best Theories to new contexts. For instance, one student explained, "on field trips you can learn words more than just memorizing them…see it in action." Another example occurred when Eduardo suggested that the class could do "a project that is *live* and *real*." Eduardo described how he and another classmate worked on a science project together creating a model of a volcano. When asked to explain what made it feel "live" and "real" to him, he explained how by experiencing a phenomenon you are privy to first-hand evidence, saying, "You're doing it for real, you're not just seeing it, you're not lying or anything, your doing it for real, you need proof, like pictures, examples." When students were considering the difference between reading about something in a book that happened versus experiencing it for yourself, like reading a book about climbing Everest versus climbing it, the distinction was made that while reading you may be "carried along but not doing [it] yourself," whereas, "in the volcano project you did it." The class referred back to the idea of learning and experiencing science words "first-hand" as students further articulated a theory for why experiential word learning might be effective:

Teacher: “What shall we call that, seeing it for yourself, seeing it action, I like keeping it real, seeing it in action, what did you call it Janey, evidence?”

Janey: “Yeah, first-hand evidence.”

Teacher: “What about it, the rest of your theory?”

Janey: “Well, I think it’s more exciting seeing it…”

Teacher: “So how does going to Hidden Lagoon, seeing in action, help us learn new words in science? Why is it going to help us learn new words in science, it’s more exciting so then what, if it’s more exciting…?”

Janey: “It gets you interested more.”

Teacher: “There’s your theory, see? She explained it, a logical argument, you see it first hand, you get excited, it makes you more interested, and then you learn your new words better. So experience in action is more exciting, does anyone buy into that theory?
Students: [agreeing] “Yup!”

Teacher: “Raise your hands if you agree with that theory, experience in action gets you more excited and more interested, and you learn more…”

Students also explained their theories for learning words experientially while coming up with research questions and hypotheses, as this small group did when Alexia said, “You can see the action while it’s happening…That will help you learn them.”

While analyzing their data, students discussed experiential learning as being particularly useful for learning the science meaning of polysemous words, observing that for polysemous words, they often already knew one meaning and were learning a new scientific meaning, such as for *community* or *producer*. They found that more students represented the science meaning after experiencing the words on a field trip compared to when they looked up words in the dictionary to study with flashcards. In the posttest questions that asked students to demonstrate word knowledge by drawing, more students depicted the science meaning of the word and drew pictures of examples they actually saw and experienced after learning experientially on a field trip compared to pretest responses and posttest responses for the other strategies. For example, students on the pretest might have drawn a picture of their school for the word *community* while on the posttest they drew an ecological community that they visited, including a wetland and it's inhabitants which they saw (ducks, coots, turtles, fish, birds, etc.). For *interdependence*, students drew pictures of algae and fungus creating lichen, shelter, and ducks in reeds. For *producer,* students on the pretest drew Hollywood signs and references to movie producers, while following the field trip they drew different kinds of plants and trees they saw. In reflecting on this observation, students theorized that by seeing the words "in action," they saw meanings relevant to science, and the words and meanings were more memorable, but when using the dictionary, they often were confronted with numerous meanings and were not always sure which was the appropriate one for science, in some cases even writing down on their flashcards the wrong meaning of the word.

In one final example, students were analyzing their data and considered which strategy was more effective. Zane pointed out a range in their histogram showing that more people did better with flash cards. Students began to theorize about why the reading strategy was least effective, and then went on to theorize about why going on a field trip may have been most effective. Allan explained how they "actually saw them on the field trip, which made it easier to draw them." Zane followed this idea by sharing, "One of my ideas about why field trip was more successful is that students were more willing to learn, more engaged."

Situated word learning. Ideas coded for this category included people learning new words in situations involving their authentic use, trying them out in context, such as by participating in a group while using the words to accomplish some task. Thirty-one video units were coded as having situated learning ideas present. One example was used by the teacher as a touchstone case of situated word learning; the teacher referred back to it frequently in later discussions as a strategy for helping students make connections, or for reminding students what situated learning was. In the unit, which took place during a class brainstorming session for how people learn new words, Eduardo described a recent experience he had when he needed to learn a new word while in a store making a purchase.

> Eduardo: "When I went to Gamestop there was, I was going to buy a Playstation 3 game, but I had a Playstation 2, the person was talking about this cue card and he was confused, and the lady was like, blah, blah, using words I didn't know…"
>
> Teacher: "Was she trying to sell you something?"
>
> Eduardo: "I wanted to buy it, I had a Playstation 2, and it was a Playstation 3 game, and there was a card called []."
> Teacher: "So this is when you are dealing with technology…"
>
> Eduardo: "I don't understand the words…"
>
> Teacher: "You understood you needed something you didn't have to play the game? To use technology, to buy something? Great example that happened in real life!"
>
> Eduardo: "To understand…."
>
> Teacher: "To understand what it is you need to buy…"

This experience illustrated many of the coding categories, including learning new words in the community, through social interaction, from a more expert other, in conversation, but especially shows word learning in the context of use with an authentic purpose meaningful in Eduardo's life. This example, referred back to frequently in the curriculum as a way to illustrate situated word learning, showed up in students' final Web of Inquiry reports, including this example from Eduardo and Efrain's explanation for their Current Best Theory:

> Field trips are the best way to see words in action, and feel it, and see how it describes the thing you are discovering. It doesn't only have to be in field trips it can be in your life, if you don't know a word and you go to a store, and you can explain to the expert what you are looking for, and the expert might know the word and he can give you the thing you want. You can see it in the situation.

Students offered numerous situations for how to learn new words from learning within a context in which the words are used or needed. These often included situations in which one needs the new word in order to communicate with someone, to understand a conversation or idea as part of a group, or to be successful at a job or task.

Theories from the word learning literature. Some of the more common themes from the word learning literature that appeared in discussions included the ideas that word learning is incremental, that word knowledge is schematic, and that to learn a word requires multiple exposures. Ideas brought up aligned with these theories from the research literature on word learning, present in 29 of the videos.

One example from the video from when students were analyzing their data included a discussion of the growth students made in learning new words even when it might have been their first exposure to them. The teacher asked how many exposures to a word someone would need to learn it well, to which Zane replied 40 times. The teacher then pointed out that the average growth the class made on the rubric for moving from the column representing never having seen or heard a word before to the column representing having seen or heard it but being unsure what it means was "pretty good for 30 minutes." This led to a discussion of the limitations of spending one half-hour studying 8 words. Adam introduced the idea of word learning being incremental in addition to involving multiple exposures by suggesting they would need to spend more time to move farther on the rubric. There also was a discussion of how the expectations for learning words well in such a timeframe itself was perhaps unreasonable, and yet the data revealed it did make a difference, students did show growth. Some follow-up suggestions were to spend more time on the same words, or at the end of the year to take the posttest again to see if students remembered the words, to find out which strategy helped learning for the long-term.

Another example of how discussions related to theories prevalent in the research literature on word learning came up when students were analyzing data from their word content assessment posttests. In these assessments, students represented all that they knew about a word by drawing and labeling pictures, writing sentence and meanings of words to show what they knew about a word, with the intention of invoking students to represent their word schematic knowledge. One aspect of this knowledge includes knowledge of the semantic field of a word, including words that are related to the word semantically. In this example, a student had drawn on her word schematic knowledge when problem-solving the meaning of scientific words by relating the new words to ones she was more familiar with. When trying to recall what *seed dispersal* was, a student didn't remember precisely, but related it to pollination by drawing a picture of pollination in action. In the discussion, the teacher highlighted how the student, Ruby, made a connection to pollen, and Ruby explained her connection, which was that she “had the same feeling something is being spread.” The teacher described dispersal as the same mechanism, spreading, with one being seeds and the other pollen. The teacher explained how the pollination process spreads pollen to fertilize flowers in order to produce seeds, while seed dispersal spreads seeds already formed away from the parent plant to prevent competition for light, water, and nutrients found in the soil. In the discussion, the point was made that to learn *seed dispersal* Ruby may have needed repeated exposures, but in this instance, she drew on her semantic field knowledge while making connections in meaning to what it's related to even if she didn't know a definition. Other examples from the content assessment included instances where students applied metalinguistic knowledge to hypothesize about word meanings, for instance recognizing "depend" as the word inside the word *interdependence*, and discussing how knowing what depend means allowed students to hypothesize about a new word based on what they already know about its parts.

Incidental learning. One area of the research literature on word learning coded for was the idea that people learn new words incidentally, present in 15 units. Students discussed how people learn new words from "exposure from around," "in the world," as well as from TV, radio, and environmental print. As Adam said, people learn new words from "encountering them in your life, signs, walking down the street." In the beginning of the curriculum, when the teacher presented the scenario of a girl visiting a family member's ranch to elicit theories of situated word learning and legitimate peripheral participation from students, students also explained how the girl learned new words incidentally:

> Reed: "By hearing her family use them, talk about the new words."
>
> Ava: "Saw them being used…"
>
> Teacher: "In action,"
>
> Jack: "By asking her family."
>
> Teacher: "She started to do…?"
>
> Jack: "To learn how to do different chores."
>
> Jesús: "She was hearing them."
>
> Tiana: "She was wandering around."
>
> Crystal: "Trying them out."
>
> Teacher: [summarizing] "Observing first, seeing them first, then started trying them out, was she confident at first?"
>
> Students: "No!"
>
> Teacher: "She was feeling them out?"

Ava: "Wondering…"

Teacher: "At the end she was participating."

Learning new words through third party participation was another incidental learning theory discussed. This included essentially intentional and unintentional eavesdropping on conversations and learning new words in the process. Some examples students gave included at home listening as parents are having a conversation, listening to a family member talk on the phone, or even waiting for a bus at a bus stop listening to another group's conversation. For instance Reed explained that you learn new words in a group "when other people are talking," and Janey added, "by listening to what other people are saying," and Allan's idea that "you learn words by eavesdropping on other people who say things."

Learning in and outside school contexts. Discussions of students' theories about how people learn new words frequently involved *both* in and outside of school contexts, present in 28 of the video units. In the following example when the class was brainstorming how people learn new words, the first ideas students voiced were more predictable, school-related contexts, but these were then followed by other, outside of school situations where word learning is more incidental. When asked by the teacher to think of more school related ways of learning words, a student shared an experience from outside of school that leads to a discussion of learning in both in school and outside of school contexts, particularly from learning through environmental print. The teacher emphasized how students are becoming aware of how they learn new words as something they do in their lives, not just in school:

> Teacher: “Think about other ways you might learn words in school…”
>
> Meggie: “I think it was last week I saw a sign that said *yield,* so I asked my mom what that meant, and she told me what it meant, and then I got home and we got into a new conversation talking about what [yield] means.”
>
> Teacher: “I think it is really cool that you can remember a time you learned a new word from last week, that you can start to think about how do we learn new words, not just during Web of Inquiry, but when we go home… environmental print, print that is around you… Maggie's example, you walked down the street, see words around you, yield, a traffic sign, you need to know these words, to take a driving test …not just not get your license, you might crash. Meggie, do you want to tell what it means since you asked your mom?”
>
> Meggie: “It means to slow down.”
>
> “Teacher: “If we are both driving, if I have the yield sign, she has the right of way…”
>
> Student: “She has to slow down, like a yellow light.”

Discussions of how people learn new words that involved learning in school contexts alone (rather than in *and* outside of school) were also frequent, present in 29 of the units. This is not surprising given that students’ were testing theories for learning new words in school. Examples of school contexts mentioned, in addition to those tested in their inquiry project, include schoolwork such as learning from word lists, work sheets, tests, bilingual classes, the teacher suggesting words to use in writing, the teacher using words on the board, asking the teacher what a word means, studying, spelling, and from English Language Development.

While pursuing their inquiry in school, theorizing about and investigating theories for learning new words, students also developed a greater awareness of community as a context for learning new words, as the previous example highlights. Even though 29 units were coded for discussions where school was a context for learning, it is noteworthy that *community* as a context for learning new words was also frequently discussed, present in 21 of the units. While community contexts mentioned in discussions often involved learning new words by participating in a club or a group, by being involved in a neighborhood, or as students often described, by "being out in the world," the role community itself can play in learning new words was also explored when a student introduced the idea that different schools are their own communities and have their own vocabulary or language of practice.

Multiple strategies for learning words. The idea that there are multiple ways to learn new words was a common theme in discussions, beginning with brainstorm sessions early in the curriculum, but it was also central to the students' inquiry. While in one way they were looking for the most effective learning strategy by testing competing theories for how people learn new words in science, through their inquiry they did not just arrive at the one best strategy. Rather, students recognized that there are multiple strategies for learning new words, and that making use of multiple strategies, depending on one's context and constraints for learning, as well as one's goals, would be more beneficial than finding and using only one which seems most effective:

> Ava: If that is the best thing to do [field trips], does it mean they have to go on it, but then what if they can't go on them?... I think if we had done all of the strategies together on one set of words, scores would have been much higher.

Discussions coded for the idea of being strategic in applying theories for learning new words in different contexts were very frequent, present in 47 of the units. Being strategic in this sense included actively considering, selecting, and using a particular strategy for learning from a wide repertoire or toolkit of strategies because, after evaluating strategies, one believes it is best suited for meeting a particular goal for learning. While this idea was originally introduced by students (illustrated further in the qualitative analysis of Video Exemplar Two), the following example shows how the teacher, building on Ava's comment above, helped developed this idea while encouraging students not to settle for finding the one "best" theory to use as an outcome of their inquiry. She not only points out the limitations in generalizing from their research to the multiple situations and contexts in which a variety of word knowledge is needed, but also models and fosters a critical thinking perspective applied to their own research and how they might go about interpreting their findings:

> Eduardo: "It's like if you [want to] learn words better you could [use] reading, flashcards, field trip, you could make a flashcard and after that you could put words on it, you could make a picture of Hidden Lagoon, what it's about."
>
> Teacher: "Research can be artificial, does a teacher or class have to only choose one strategy? Could a teacher decide to do all these strategies?"
>
> Students: "Yes!"
>
> Teacher: "Maybe each of these strategies is useful for a different purpose, meeting a different goal, for a different reason. Maybe flashcards are good to

> introduce a new word, then read about it, then go on a field trip…that wasn't the research design, it was set up to compare these three things…"

In another example, the class deliberated about whether certain strategies might be more useful for the long run. The class was discussing whether, overall, students remembered the field trip words better than the flashcard words, or whether reading the words in a text was better than using the words during a field trip for long-term memory. They wondered whether they might be able to say which one of these strategies is most helpful in the long run. The teacher, building on a student's idea that the strategies they investigated may be useful for different goals, suggested that flashcards might be useful in the short-term, like if they have a test the next day. The teacher went on to suggest that if they wanted to understand something really well, if, for instance, they are really interested in it, flashcards and dictionaries may not be as helpful as going on a field trip and experiencing it for themselves in the company of someone who knows more about it. This led a student, Jess, to consider ways one might develop one's own learning strategies, recognizing that different strategies might work well for different people, that it "depends on the person," and suggesting students making up their own strategies (see Video Exemplar Three for further analysis).

Learning words in social contexts. In 40 of the video units ideas for how people learn new words included a social purpose for learning, and a social theory for learning words emerged. Many of the examples already provided illustrate the involvement of social contexts and purposes for learning. These include learning new words by being part of a group, understanding and communicating with others in a group, using words in a particular social context such as when making a purchase in a store, and by acquiring a new skill in a group such as learning to communicate in a new language. One particularly important sociocognitive word learning theory students discussed involved the idea of learning new words from some more expert other. This idea was coded separately as an emergent pattern and will be discussed in the following section where results from emergent codes are presented.

Just as was the case for the predetermined categories for how people learn new words, more emergent categories were identified for this question than for any of the other three questions of the Word Learning Theories Assessment, with a total of 30 categories. The more frequent emergent categories are important as they reveal the content of discussions that occurred during instruction which help to explain the processes that have led to changes in students' thinking. However, even those emergent categories with lower frequencies are informative as they help to show the range and variety in theories for how people learn new words discussed. Frequencies of the 30 emergent categories ranged from being present in one unit to 81 units.

Awareness of word learning processes. Students showing an awareness of word learning processes and a critical, analytic stance for evaluating learning strategies was the most frequent category found in video discussions. This category, present in 81 units, had the highest frequency of any of the categories, both predetermined and emergent, for all of the four questions (the second highest being going on field trips to learn new words with a frequency of 69 units). Having the highest frequency and being present in over half of the video units show that students' metacognition about their own learning processes were significant in the curriculum.

This is clear in many of the previous examples illustrating other categories as well, such as the one in which a student, Ella, suggested that flash cards may not be as effective a learning tool for remembering words for the long term, sparking a discussion of how students' should be to be aware of their own learning goals so that they can flexibly and critically select the appropriate strategies that serve their individual purposes and goals as learners. In order to do so, students not only would need to be able to evaluate different learning strategies for meeting a variety of purposes, they would also need to be aware of a variety of learning processes and be able to evaluate their effectiveness. Since this was the focus of their inquiry about learning words, students became practiced in this kind of thinking. Through their inquiry, and data analysis in particular, they developed awareness of the process of coordinating theory and evidence, and how evaluating the success of particular strategies and perceiving which one is indeed most effective relies on an understanding of one's goals for learning.

Discussions that fostered students' capabilities in becoming critical of their learning goals often went hand-in-hand with questioning how well they wanted or needed to learn a word and for what particular purpose. In one discussion, students considered how choosing learning strategies would depend on whether their goal was to really learn words well over time, or if they need to know them for a short-term goal. Students agreed that using a strategy for memorizing words and their definitions would be more useful for a particular academic goal of performing well on a test than some other strategies. In another unit, students were looking at patterns in their data in order to come up with a Current Best Theory about which strategies for learning words were most effective. They began to look at the implications of their findings, and to come up with ideas and concerns about how their theories might be usefully applied to learning contexts and policies in school. One student brought up the potential constraints limiting students and teachers from going on a field trip, which led to a discussion of how the real finding of their research might not be that one strategy is better than another, but instead arguing for the value of learning experientially in the field on field trips outside of school, and for its benefit for teachers and students in developing word consciousness and an awareness of language associated with a learning topic and experience.

An experience shared by two students early on in the curriculum was used by the teacher in explaining the concept of word consciousness to the class. The girls, who sat at the same table group, shared how they decided to begin systematically keeping track of words they chose to use in their writing. They had, informally and of their own initiative, started to investigate their own learning with respect to how many words they used when they wrote. This illustrates students' growing awareness of their own learning processes, as well as their developing word consciousness.

Another example of students demonstrating growing metacognitive awareness of word learning processes was seen when they evaluated their learning strategies while analyzing their data and interpreting their results while coming up with a Current Best Theory. In these discussions, students reflected on why reading was the least effective of the strategies tested, and came up with theories not just to explain these results, but also to understand and arrive at a more effective approach, utilizing and coordinating a plan for word learning that incorporated multiple strategies. In such discussions, the teacher simultaneously modeled and engaged in such thinking, theorizing with the students, while also connecting to and building on students' ideas. In the example below, the teacher posed some big questions to the students, asking them to consider why reading may not have been as effective as other strategies in their study, whether their study might lead to some conclusions about reading as a word learning strategy, and how their theory might be put to use or further tested:

> Teacher: "What about the reading, I mean as a teacher do you think I think reading is important, valuable, and good? Do students think it's a good thing?"
>
> Students: "I like reading, yeah."
>
> Teacher: "[It's a] good way to learn information?"
>
> Student: "Good for learning information, but not really words."
>
> Teacher: "I'm starting to think reading is not the best way to introduce new words in science, maybe it's better to use it to reinforce…who was it that said maybe it was a good idea to go on a field trip first or make flashcards, then go

on a field trip, then read about them? I'm starting to think reading is the thing you should do after, when you've already…"

Jess: "I think you should go on a field trip, then learn a lot a lot of words, then you can read a really good book about it that has all the words, then you can read the book and make flashcards, like food chain, read more about it, then make flashcards, then you find out what food chain means. Like yesterday, we read *Ocean Days* and we kind of figured out what food chain was, so like it was pretty much in order from field trip to reading to flashcards."

Teacher: "And do you need to make flashcards for every word?"

Students: "No, no."

Teacher: "Maybe you would just what?"

Pablo: "Just make flashcards for the ones you haven't learned very well yet."

Teacher: "Yeah, maybe the ones that are really hard to remember or hard to understand, maybe those are the ones you would go and look up in the dictionary, maybe you don't have to do all of them you just have to choose the ones that…"

Jess: "That you need help with."

Teacher: "So you're strategically using all these strategies to help you learn to the best of your abilities."

Building capabilities as self-conscious, efficacious word learners. The second most frequent emergent category was evidence of the development of students in becoming word conscious, self-efficacious word-learners. This included units which showed students' awareness of acquiring strategies for learning and applying them in a variety of ways to meet their own goals. There were a total of 55 units coded for this category. In the transcript of the class discussion above, students showed evidence of ways in which they were developing awareness of and critically evaluating learning processes. Jess, in articulating her thinking in this example, not only presented a strategic learning theory and approach to learning words, she also demonstrated how she is thinking as a self-efficacious learner. Her idea shows how she is able to act upon knowledge of her own ability to accomplish tasks to meet goals. Indeed, she makes use of that knowledge in her theory, showing that she is capable of also thinking critically about how she—or anyone—is able to take charge of their own learning approach and thoughtfully plan strategies to use in order to best and most meaningfully or effectively reach their goals.

While this was a fundamental and underlying goal of the curriculum, conducting inquiry into their own learning processes provided numerous avenues for advancing this idea in a concrete way. In one example, when asked by the teacher why these theories could be useful to know, several students said "to learn more," while one student, Ryan, suggested a different goal, saying "to learn *better*," This shows an understanding of how learning about which learning strategies are most effective for developing a deeper understanding might help one to become a better, more expert learner. Many video units included examples of students showing greater awareness of words around them, with students reflecting and articulating ways they were becoming more word conscious. In the analysis of exemplar video unit discussions that follows this section, I present further examples of students developing capabilities as self-efficacious, expert learners.

Metalinguistic awareness in learning words. Fifty-three of the units were coded as having some discussion in which participants either demonstrated or were encouraged to develop an awareness of how words, their meanings, parts, and semantic field may be analyzed or manipulated. Here the goal was for students to develop capabilities in reflecting on words, word schemas, word meanings, word parts, and their use. In this category, metalinguistic knowledge is discussed in relation to how people learn new words, and included processes such as learning a word as a new label for a known concept, use of cognates and learning across languages, developing word schemas, and accessing prior word knowledge within a semantic field when encountering unknown words. This also included discussions in which students developed an awareness of different types of words, differences between academic language and common words, relationships to cognates and Latin roots, as the meaning of word parts and connected words. Students reflected on academic words in the language of practice they were developing while engaging in inquiry, and considered whether they also heard or used them at home. The teacher then used these reflections to help students analyze their use of language across these domains.

Students were also encouraged to develop and apply their metalinguistic knowledge and awareness of words and word learning while critically evaluating word learning strategies and processes. A common situation in which students did so was while reflecting on using the dictionary as part of their strategy in testing the use of flashcards for learning new words. Students developed an awareness of how well dictionary authors crafted definitions, particularly when reading definitions in dictionaries written for elementary students that used familiar words and examples.

Learning words through social interaction and from a more knowledgeable other. The next most frequent categories in the video units were learning through social interaction and learning from a more knowledgeable expert-other, both found in 44 of the video units. The idea that learning new words involves social interaction was also coded in the predetermined category of word learning being socio-cognitive, but in this emergent category, specific forms of social interaction were coded. Some examples of the forms of social interaction students offered in their theories about how people learn new words included asking someone, participating in conversation, listening to your parents, and asking your parents. While a broad array of such general forms of social interaction were mentioned, the more specific idea involving social interaction that people learn new words from a more knowledgeable, more 'expert other,' was one that was central in students' theories for how people learn new words. This idea came up in multiple places in the curriculum, including in students' initial brainstorms, in coming up with theories and learning strategies to test as a part of their research, and in following their data analysis while developing their Current Best Theory. Discussions that introduced the idea that one may learn words well with the help of someone more knowledgeable came about in the context of discussing experiential learning in context. After Lena suggested learning about a topic experientially, saying, "Maybe you could go to a place where it is found and see how it is," the class began to reflect on ways they learned experientially while visiting an aquarium on a field trip. Students described how they learned by "touching," "discovering," and by spending time with a docent. Students described how the docent told them about the animals and plants, and the teacher defined what it meant to be more 'expert' in something, saying that "sometimes an expert is a tour guide, a person in your class who knows a whole lot about yoyos, horses, drumming, hockey, recorders." The teacher went on to ask the class to reflect on what the docent did for them, which led to the ideas of pointing out things, explaining things, helping them to notice things like different animal behaviors, and so on.

In another example of how one can learn from experts, Pablo suggested a learning strategy involving experts in a different way, suggesting that they should first learn from reading experts' books and on the internet, and then from experts in the field. In this example, which is described further in the analysis Video Exemplar Two, it is noteworthy that Pablo brought up the fact that experts can be utilized in learning in the classroom as well as in learning experientially on field trips as with a field guide or expert accompanying you. He presented a strategic theory for how both sources of expertise can be beneficial when used in a sequence where information is front-loaded then experienced first-hand.

In another discussion, when students were coming up with their Current Best Theories, students were asked to take what they learned from conducting their investigation and to relate it to how they learn words outside of school. In particular, students were asked to relate learning experientially on a field trip to Eduardo's touchstone example of learning in a store, and to think of how these two situations were similar. The teacher asked students to think about how Eduardo was in a situation where he needed to know a word because he had a goal (to be able to have what he needed to make his Playstation game work), and how there was a person showing him, using other words to help him understand a word for a part. She then asked the class "how is that similar to learning on the field trip?" Lena replied, "Well, on the field trip, when we had the people who already knew the word explaining it to us, it was like at the store, and they were telling him what it was." After emphasizing that in both cases there were people who were more expert explaining words, Leila added, "Like what Adriana said, they already knew the word the people at the store, they were giving examples of it," and Pablo added "Experts who knew about the stuff were teaching you about the word…If you're learning words about nature and you're out in nature, you're seeing a bunch of examples of the word, and if you're in a store, there's a bunch of video games, you're seeing examples of the word that he's teaching you, because it's about video games."

Learning using a dictionary. Using a dictionary to learn new words was present in 36 units. This category is not unexpected since students used the dictionary in testing their flashcard learning strategy. What is interesting is how students parted from their initial ideas that using a dictionary is a fundamental way to learn new words. The majority of units revealed students were critical of dictionaries as a learning tool. For instance, when discussing the use of flashcards as a strategy while analyzing their data, students noted that while flashcards were "OK" and "It was the second highest," Lena offered the idea that "Maybe the flashcards didn't do as well as field trip because some people couldn't find the definitions of the word [in the dictionary]." The teacher, building on the idea, asked the class what else could be hard about using the dictionary, to which Lena replied that a student might not understand the definition, or might encounter two definitions for one word and not know which was the science definition.

Learning new words from the text they are reading. Another emergent category present in 33 units was the idea that how people learn new words can be influenced by the text they are reading. Just as the aforementioned category of dictionary use, this category aligned with learning strategies students tested in their inquiry research. Students developed a critical stance towards the factors in text that make it challenging as a strategy for students use in learning new words. Some of the considerations in text discussed included that there are a variety of different text types, and limitations presented by text level or difficulty, and problems in the text itself. For instance, students brought up that the text may not define a word, that it can be harder to find the important words in text, and that there is often a separation in text between a word and an explanation or example.

One class discussion illustrates how students theorized about the impact of text considerations on learning new words in science while reading. In this discussion, which took place while the class analyzed their data, Janey explained how a word used in the text could be "far away from where it is explained," making it "too hard." Ava went so far as to say that science textbook writers are "out of touch with their audience," and that they assume their readers know too many words. Another student built on this idea by saying that they use too many infrequent and unknown words and difficult vocabulary. Allan, playing the devils' advocate, argued that the writers might think the teacher will explain the words in the lesson, which assumes that teachers will explain words or that students have prior knowledge which they might not. Janey went on to express frustration at having her working memory overburdened, describing how she would read a word, "sort of knowing what it means," and then have to remember the meaning "20 words later." Ava took her critical stance even further by suggesting that textbook writers are often inexperienced, trying to get through it quickly, and Allan also acknowledged how text doesn't often have the definition, that "They don't actually say, you will just know it from context." Ava followed by pointing out that definitions could be hidden, and "not the thing that stands out."

Problem solving strategies when encountering unknown words. The next three emergent categories in video units were somewhat interrelated, involving problem solving, research, and motivation for learning. The first of these involved using strategies for problem solving when encountering unknown words. Thirty-two of the video units included conversations where strategies for resolving meanings of unknown words were discussed. A number of strategies for problem-solving word meanings were discussed, including the use of prior knowledge, word schematic knowledge, context, metalinguistic knowledge (such as of word parts), and finding examples or explanations of the word in text. For instance, using context as a problem-solving strategy for learning new words was brought up by students while brainstorming how people learn new words in the beginning of the unit. In a discussion about how considerations in text may make it challenging to learn new words in science when reading a science textbook, context was offered as a strategy. Students made the point that when texts were written in such a way that made examples and explanations of words appear at a distance from the words themselves, one would need to know how to use the strategy well for it to be effective.

Conducting research and investigating. Conducting research and investigating was brought up in 25 units as a way to learn new words, and offered as a strategy for problem-solving meanings of unknown words. In the discussions, students suggested that people can learn new words by investigating them in a variety of ways, such as by using library books, going online, or asking someone more knowledgeable such as a teacher or expert. They also suggested inquiry or inquiry processes, like doing a research or science fair project, finding evidence and examples, asking questions, inventing things, and using the Web of Inquiry. Experiential learning was key in these examples, as students described ways to learn new words that involved "seeing in action," "experiencing words," "seeing for yourself," where it's "live" and "real," and from a more knowledgeable other. For example, Jack suggested, "if you want to go learn more about marine life, go to an aquarium, or about flowers, to an arboretum."

In addition, discussions of types of word knowledge, how well a person needs to learn a word, or their purpose for learning new words were all also brought up in the context of offering investigation and research as approaches for learning new scientific words. For example, Janey offered the idea early on that learning new words for a test might just require simply memorizing a definition. Later on, the idea that different strategies might be better for different learning goals came up when students were analyzing data, suggesting that flash cards might be better for learning definitions, while more experiential, research-based approaches, such as the field trip strategy, could help students to identify more examples of a word. Jack cited evidence from their posttests of how it was easier for students to depict examples of a word and use them to build a word schema following their use of the field trip strategy, after seeing examples of the word for themselves in context.

Motivation for learning new words. The idea of motivation for learning new words was present in 23 of the units. Students theorized that going on a field trip and learning experientially was a more motivating and engaging way to learn words. Students debated whether the field trip was most successful because it was more fun and engaging, but entertained alternative theories that it also might have been more distracting for students to be outside and social among friends. Discussions about motivation included how it is important for building self-confidence and influencing how hard you work, and that lack of motivation can interfere with learning if you "are tired and stop trying." One student explained their theory relating motivation and experiential learning by saying, "if you are out and moving, you get more excited and want to learn more, and pay more attention." Students also suggested that seeing a word's relevance, value, and importance helped motivate students to learn them.

What it means to know a word. Predetermined categories from the results of the Word Learning Theories Assessment, along with emergent categories, for what it means to know a word are found in Table 22 below. Just as for *how people learn new* words, patterns for *what it means to know a word* were more frequent in video units than were patterns for *why people learn new words* and *when people need to learn new words*. Similarly, just as students had explicit discussions about how people learn new words as part of the inquiry curriculum (for example, when planning their investigation), students also engaged in explicit discussions about what it means to know a word.

TABLE 22
Video Discussion Units Related to What it Means to Know a Word

Assessment Categories that Showed Changes	Frequency in Video Units
What does it mean to know a word?	
Word knowledge is schematic, word schemas	33
Can picture word and what it's related to	30
Can define it	27
Aligns with word learning literature	23
Know how to use it correctly in different ways, contexts	22
Know it's meaning	21
Can give an example, synonym	20
Situated, in context of use	14
Knowing for a given purpose	11
Sociocognitive, knowing is for a social purpose	10
Metacognition Taxonomy	
Metalinguistic features of words influence word knowledge and word learning	21

Patterns in Emergent Ideas Coded for in Video Unit Discussions	Frequency in Video Units
What it Means to Know a Word	
Learn a new concept	47
To experience it	32
Able to picture it and what it is connected to, can describe it	29
Word knowledge is incremental	23
Understanding requires more than just memorization	21
Can tell, explain, describe the word to someone else	13
Word knowledge multi-dimensional, different ways to show you know words	12
Self-assess, reflect on word knowledge	12
Involves memorizing, remembering a word's meaning	12
Know it for a test	12
Learn new label for a known concept	11
Learn new meaning for known word	11
Know multiple meaning words	7
Can read the word	6
Can pronounce the word	4
Can use the word in writing	2

Total Video Units, n=145

The most prevalent predetermined categories present in video units were that word knowledge is schematic (present in 33 units) and involves picturing a word and what it's related to (present in 30 units). These categories were characterized by discussions of what a word schema is, and included the ideas that word knowledge is multifaceted, with different types of knowledge that all relate to a word, together forming a schema for the word. Discussions of this sort involved identifying metalinguistic knowledge of a word, such as morphological word families or word parts, pronunciation, spelling, part of speech, and how words are related or connected to other words that are a part of the same semantic field. The notion that metalinguistic features of words influence word knowledge and word learning was also found to be present in 21 of the video units.

Metalinguistic features of words. The teacher introduced the idea of metalinguistic features of words contributing to developing deep word knowledge in early on in the curriculum by having students think of their school carnival and the words “Ocean Park Carnival,” asking them what it really means to know those words. She chose this example since all of the students had experienced the carnival. In this example, the teacher asked “Is *really knowing* a word more than knowing what it means, it's definition, and being able to use it? Is it more than that? What do you think of when you think of Ocean Park Carnival?” She had the students close their eyes and picture everything they could, sharing the images they pictured. Students shared their images, which included “games,” “a lot of people,” and sounds, like “people having fun,” “screams and laughter,” and drawing on all of their senses to picture, they included smells, such as of foods like “pizza,” “burritos,” and the setting in general, which one student described as “evening turning to night.” The teacher summarized their ideas by saying “You can picture it, you know Ocean Park Carnival as words, you know what it is, you can use it in a sentence,” to which Jack proposed that knowing these words, really knowing them, meant being able to *visualize* it, an idea which Allan then added to by suggesting one has to experience it. This discussion concluded with the idea that to really know a word, you need to know all the things that relate to it, and to see how they are all, as one student said, “connected.”

Definitions of words. The relationship between a word’s definition and meaning is a close one, however, knowing a word’s meaning entails having a more general, practical, or applicable knowledge of a word's definition, which is made use of when encountering it in a conversation or while reading or listening. More formal or precise knowledge of word definitions is less necessary for the goals of communication and situated understanding. In 27 of the video units, word knowledge was equated with knowing a definition. While this was a pattern found in the assessment results for the whole class, it was not for ELs as a group who more often equated word knowledge with knowing a word's meaning, present in 21 video units. It is likely that students learning in their second language find themselves more often in circumstances where they need word meanings for a situated purpose. Many such situations likely involve social purposes in learning, such as communicating ideas and developing a shared understanding. This is supported by the results which showed ELs (and not the class as a whole) viewed knowing a word as sociocognitive, or involving a social context in which such knowledge is demonstrated and put to use, and which was present in 10 video units. For example, EL students suggested that one way you can show you know a word is to "tell people," or to be able to "say it," and "use it." To a student learning in a second language, such instances show the value of knowing a word's meaning by being able to put it to use in their everyday lives. Knowing a word's precise definition (or definitions in many cases) is less relevant to day-to-day learning goals or situations involving a shared, social purpose, such as communication.

Alignment with the word learning literature and using it correctly. The next most frequent patterns from the assessment results found in video units included ideas for what it means to know a word that align with research on word learning (present in 23 units) and the idea that knowing a word entails knowing how to use it correctly in different ways (present in 22 items). Many of the examples aligned with the research literature included students taking a stance that knowing a word involved more than simply memorizing a definition, that word knowledge is complex and multifaceted, and that to know a word well requires being able to use the word in flexible ways while speaking, reading, writing, and listening, "more than just memorizing them." Students demonstrated their ideas about the complexity of word knowledge as well as their developing metacognition regarding word learning, by offering numerous ways and contexts for demonstrating word knowledge. Some of these included that if you know a word, "you can use it in a sentence," or "communicate with it." When thinking of ways to show if they learned words after using the different strategies, students suggested they could "try them out" and "take all the words and use them in a story," "taking a word and using it," as well as "show an example, use it, show it, play tricks with it." One student suggested, "you can understand it and by understanding its meaning, say it fluently." Lena brought up that you can demonstrate knowledge by knowing and using a word in two languages. Finally, being able to know and use synonyms for words was discussed as a way to expand schemas and knowledge of what is related to a word, present in 20 units.

Situated nature of work knowledge. The idea that word knowledge is situated in the context of its use was present in assessment results and in 14 video units. While knowing a word is always situated within a context, students demonstrated awareness that word knowledge depends on the context in which it is being used or encountered, and that knowing a word requires using a word for particular purposes and to meet specific goals. For example, one student expressed how word knowledge develops through situated learning and exposures, explaining that you know words by "encountering them in your life, in signs, walking down the street, from your parents," while another simply stated knowing a word means, "being able to communicate with it."

Using a word for a specific purpose. A pattern from assessment results that was present in 11 units was the idea that one can use a word for a specific purpose. Moreover, students developed an awareness that different learning strategies might be better suited for developing different types of word knowledge, such as knowing a definition versus being able to use the word when writing, or being able to picture the word and what it is related to. For instance, while discussing their results, one student suggested that they might need to spend more time to do a harder test, which led to a discussion of how different types of test questions require different types of word knowledge, and that a student could learn or know a definition for the purpose of answering a test question, or they could investigate a word to develop a more enduring understanding and even be able to test for that by assessing one's knowledge of those words months later.

Patterns in emergent ideas for what it means to know a word help develop a more nuanced understanding of students' ideas. The most frequent of these provide evidence of how discussions students had about what it means to know a word contributed to an epistemological view of word knowledge that is more multifaceted and complex than more traditional, simplistic notions equating word knowledge with knowing definitions (which were more prevalent among students before engaging in their inquiry).

Concepts conveyed by words. The most frequent of all of the emergent ideas discussed was that knowing a word involves learning a new concept rather than learning a definition (present in 47 units). Student examples in discussions related learning new concepts for words specifically with learning the academic language of content area words, such as in math and science specifically. Discussion of content area words representing new concepts was often present when students were planning their investigation and considering different types of words and which should be included in their research. This step in their inquiry led students to reflect on ways words differ, and to theorize about how best to learn different types of words. These discussions also provide examples of how students' ideas aligned with ideas prevalent in the research literature for what constitutes word knowledge (present in 23 units).

In one discussion, for example, when students were debating how many words would be realistic to attempt to learn in each session, Ava brought up the related issue that the type of word would be important to take into account, saying that "we need to know what kind of words to decide how many," and giving an example that if they were all "easy" words, like "cat, mat, sat" it would be easier to learn more. This led to a deeper discussion of types of words, and how it is more challenging to learn a word that is an entirely new concept (words which Beck, McKeown, and Kucan [2002] call *Tier Three* or *Brick Words)*, with the teacher giving the word *allelopathy* as an example. Asking students if they knew the word or had heard it before (none had), she then used it to illustrate learning a word that is both a brand-new word and a new concept, and shared it's meaning (plants sending out chemicals from their roots that other plants don't like as an adaptation to protect its space for growing). Another type of word brought up in this discussion were related words, such as words that make up word families, to which a student proposed "if all [the words] are related we could do more." The teacher pointed out that this student was proposing how prior knowledge of words or aspects of words can serve as a generative tool for learning new words, a way that people could "use what you know to learn more words" and expand their schemas for known words. In further considering and developing a typology of different word types to learn, Ava brought up yet another word type by describing how you can learn a new word for an already known concept, attaching a label to a concept for which you have already developed an understanding or for which you already "know the meaning," simply learning a new word to call it. This type was from then on known to the group as attaching a new label to a known word, and which was an emergent idea found in eleven units pertaining to what it means to know a word. A final type of word identified in this discussion included words common to multiple contexts, or high-utility words that could apply to a lot of situations, also known as *Tier Two* or *Mortar Words* (Beck et al., 2002). The importance of content words in science and considering different types of words came up in follow-up discussions on different days. For instance, during the next meeting Alan reminded the class that "We need to learn words we don't already know, to learn new science concepts," and Ava and another student proposed the idea that "we don't have to choose all the same type." After a vote, there was a general consensus that it was important to have science content words represented in the words chosen for inquiry, but Allan, reflecting on words and the different types there were, observed that a new concept could also have a word family, and asked, "knowing there will be overlap, should some of these words include new ideas in science"? Students ultimately decided by voting that some words should be new science concept words and some should be high utility words or words that are part of a familiar word family. Ava described how one might expand their word schemas by acquiring new meanings for known words, saying, "Some words you are familiar with, but don't know the science context." Jack referred to this idea the next day as "words where you know the concept but not the word." Jack also referred to the idea that words are polysemous, that "we could choose words with multiple meanings," an emergent idea present in seven units. Ultimately, while students saw the value in learning all these different types of words, when asked to choose one they thought was most important for learning words in science, they chose new concepts. The deliberations and outcomes of students' collective decision-making in these discussions reveal important aspects of students' epistemological stance towards knowing a word. Moreover, what is truly exciting are the metacognitive capabilities the students demonstrated while reflecting on word types, how they are learned in different contexts and for different purposes, and how certain types are more appropriate for developing academic language in the content area of science. Indeed, these are the same types of metacognitive tasks prominent vocabulary researchers are asking teachers to engage in to help their students acquire vocabulary (e.g. Scott, 2005; Scott et al., 2012; Bravo & Cervetti, 2008; Snow, 2008;).

Experiential learning of words. The frequency of the emergent idea that to know a word entails experiencing it (present in 32 units) shows that students not only viewed experiential learning as an important approach for how to learn new words, but that it was critical to their developing epistemology for word learning. Like patterns in the assessment results, students in discussions often related experiential learning with the development of word schemata. This included the idea that people develop deeper understandings and knowledge of words through experiences, and then are better able to picture a word and what it is connected to (present in 29 of the video units), as well as to think of related words and words in the same family, and to describe the word and its semantic field. Students suggested concrete ways to draw on word schemata in demonstrating knowledge of a word, such as in thinking of related words, or describing a word's semantic field, along with "visualize a word," "draw it," do a "quick sketch," and "write a description of it" and "what it's related to."

Word learning is incremental. Another emergent idea from students' discussions was the notion that word knowledge and word learning is incremental, present in 23 units. This coding category included the idea that there are different levels of knowing a word, and that one can develop a greater understanding of a word by building on prior knowledge of words. Conversations revealed understandings that deeper knowledge of a word develop over time, through multiple encounters with the word, and by having many types of experiences with it, such as in situations where people use the word and you hear it, when encountering the word while reading, or having experiences in the world in which the word and it's concept are important.

In one example when students were discussing what it means to know a word, Janey brought up that knowing a word includes both "knowing the meaning of it," and "being able to communicate with it." The teacher used this example to emphasize that there are "different types of word knowledge, knowing how to pronounce it, it's meaning, how it relates to other words." In response to this, Janey suggested that, "If you're talking to someone and not sure of a word, you can use a different word, a synonym." The teacher expanded on Janey's two points; first, that there are different types of word knowledge, and second, that there are different levels of knowing a word, that "it's not as simple as you either know it or don't, you can have seen it before, heard it, but not be sure what it means." Since earlier in the day the class had been talking about the President's inaugural address, the teacher used the word *inaugural* to illustrate knowing and being able to use a word without being able to give a precise definition, which led to a discussion of how it is also possible to know a definition yet not be able to use a word.

Another example of word knowledge being incremental described earlier was when the teacher asked the students what it meant to *really* know the words *Ocean Park Carnival*, asking "is really knowing a word more than knowing what it means, knowing it's definition and being able to use it, is it more than that?" We saw how students offered a plethora of different sensory images and experiences of the school carnival in response to this question, developing the idea that knowing these words involved their experienced with them, their ability to visualize them, and to see how they are all connected. Students recognized how one might not have all these levels of knowledge or experiences that allow for such a deep understanding of a word.

Finally, the idea that word knowledge is incremental was central to some of the most important discussions of what it means to know a word, and took place when students were grappling with how they would assess their knowledge of words after testing the different learning strategies in their research design. In both years, the students decision to create pretests and posttests to use as tools to measure how well they learned words using the different learning strategies, and their process of co-constructing a rubric for scoring and assessing growth (described earlier), proved to be especially important in developing the idea that word knowledge is incremental.

In year one, when the students were thinking about types of questions they should include on their posttests, the class began to brainstorm ways to show you know a word. The teacher began recording the students' descriptions using an overhead projector, and together they aligned the students' descriptions under level headings as they developed a rubric together on the overhead screen. Students began by suggesting they should include knowing a definition and a word's meaning. The teacher recorded these, and then used her and the students' knowledge of and familiarity with the word "technology" to illustrate this idea. One student volunteered to define the word, then stopped, running into difficulty as she realized she couldn't easily and lost confidence, saying, "I can't, but I can give an example" and pointed to a computer, saying "I know what it means but…" To this the teacher replied that sometimes you could be able to give an example but not a definition. The teacher then suggested an order in which one might sequence the levels of knowledge students suggested so far, saying to Tiana "We'll move yours over, so, you've seen it, heard it, can give examples of it, can use it, now if you really know it then you can say what?" Students replied in a choral response, "The definition!" The teacher referred back to the touchstone idea of knowing 'Ocean Park Carnival,' and connected this to the levels of the rubric, saying, "I need help to capture this," to which a student said for the highest level of knowing a word "You're in it." The teacher suggested to frame it as if you are asking yourself a question about what you know about a word, to which Jack responded "Can you visualize it?" The teacher incorporated 's ideas from earlier, saying "I like Liza's idea about the word and details connected to it, can I visualize it and...." After a pause, Liza suggested, "Feel it," Jack offered, "Surround it." The teacher added to "Can I visualize it and *things that it's connected to*." Then, going back to the question of what the definition of technology was, the teacher offered her own definition off the top of her head, modeling how defining a word you know is not something you do everyday, that it takes thought, and that it is not an easy task. Still, she came up with one, that technology is a tool or set of tools that can help one accomplish a goal, and went on to give a number of less obvious examples in addition to the ones students called out (computer, iPhone), adding ones such as "light bulb." The teacher finished recording the descriptor for highest level of knowing on the rubric with the question "Can I visualize it and things connected to the word?"

In year two, students engaged in the same tasks, coming up with levels for a rubric that could be used to assess how well one knows a word. The teacher used some of the same approaches from year one to create opportunities for students to theorize about the incremental nature of word knowledge. Another memorable example of ways in which word learning was viewed as incremental in year two came from Eduardo, an EL student, as he reflected on the developing rubric students were co-constructing, and shared his observation that the levels were like a developmental progression for learning across their lives:

> Eduardo: "It's like life because you don't know it, this is like the future [pointing to the farthest column on the rubric chart], and this is like now [pointing to middle of rubric], like you don't know it, and in the middle you've seen it, and you can use it."
>
> Teacher: "It's sort of like this is our goal, this is where we're striving to be, and hopefully going on a field trip, we'll see if we move towards this end, or maybe by reading, or maybe by…."
>
> Students: "Flashcards!"
>
> Eduardo: "It's like level 1, level 2, level 3…"
>
> Teacher: "Yeah, these are like levels, and this is our goal, we want to be here, and it is going to happen in life."

Word knowledge is multidimensional. The examples above also illustrate students' developing understanding of the multidimensionality of word knowledge, present in twelve units. This was often accompanied by the ideas that there are different ways to show you know words, and that understanding a word requires more than just memorization (found in 21 of units). Many of the specific forms of word knowledge discussed entailed demonstrating knowledge-in-use. Some of these included that when you know a word, you can read the word (present in six units), you can pronounce the word (present in four units), and you can use the word in writing (present in two units). Moreover, most of the ways to demonstrate word knowledge discussed included a sociocognitive component, involving social interaction and communication with others, such as being able to tell, describe, or explain the word to someone else (present in thirteen units).

Metacognitive awareness of their word knowledge. Finally, metacognitive awareness of the purpose for knowing and evaluating learning strategies and situations where they can be most strategically applied was present in twelve emergent categories. Discussions about word knowledge that included its acquisition or assessment often incorporated the idea that word knowledge entails one's self-assessed knowledge of words as well as of one's capabilities, reflecting on one's own word knowledge. These ideas came up particularly in the context of discussions in which students considered how they would assess their knowledge of words in conducting their research, as students grappled with the question "How are we going to actually measure whether or not we learned the words?" To this Meggie proposed the idea of creating a checklist for students to use to self-assess their word knowledge. Though Meggie's idea was to use this as a tool to choose words to learn that fewer students already knew, the idea was taken up by the teacher and used to propose a way to measure word-learning growth following the use of each strategy:

> Meggie: "We can give everybody a list of words on a paper and they can circle the ones they know, and then you could pick other words and do it until nobody knows them."
>
> Teacher: "Meggie is saying we should choose words that no one in our class knows, what is the chance of us being able to do that, do you think it's going to be easy or hard thing to do?"
>
> Stephanie: "Hard thing to do."
>
> Teacher: "Why?"
>
> Stephanie: "People might know the word and other people not, people say I don't know it, and I know it."

Teacher: "And it may be very difficult to actually find words that no one knows, what do you think about Meggie's idea ….of doing this check list where we circle the words before we do the strategy, then do the checklist again?"

Students: "Yeah!"

Teacher: "Is that a way we can learn how many words people learned?"

Students: "Yeah!"

Teacher: Thumbs up if you think so, Students: [Show thumbs up],."

Learning strategies. Finally, students reflected on the learning strategies themselves in discussions where they considered what it means to know a word. In one example, after students had collected their data and were beginning to analyze it, Janey shared her experience using a word list as part of the field trip strategy. The list was given to the adult 'experts' and to the students so they would know what words they were supposed to learn. However, Janey began to use this list in an unintended, formative way, saying that she thought one of the most valuable parts of the field trip strategy was that she had a "little list of things that was helping me to look for things and notice what I was seeing." Later in the discussion, the teacher asked Janey how the list helped her. Janey explained that the list helped her answer certain posttest questions, in which she was asked to give an example. While it is not surprising that the field trip strategy helped with providing examples of words, since it hinged on finding evidence of a word in nature, Janey's reflection on how she used the list and how this aligned with the scoring rubric is an interesting example of how a student developed metacognitive capabilities while analyzing their use of learning strategies while evaluating their own word knowledge.

Students reflected on their own word knowledge and learning as they considered ways that the different learning strategies might be strategically applied in helping achieve particular learning goals, and often evoked memory, memorizing, and remembering a word's meaning in thinking of whether they knew or had learned a word. Along with the memorization and rote learning view of word meanings discussed, the idea that word knowledge is constituted by what is needed to be known for a test was also present in twelve video units. Memorizing word meanings or definitions is often considered a more typical or traditional epistemological representation of word knowledge, particularly for assessment purposes. In one discussion, such an idea was brought up in the context of reflecting on one's own knowledge in an inquiring way, introducing a metacognitive stance towards word learning that suggested learning approaches might be employed in a flexible and strategic way to serve one's own goals for learning.

Results of recoding video for students as theorists, critics, and expert learners. Collectively, the previous analyses help to characterize students' developing metacognition. An important outcome of the previous video analysis was that of bringing to light three overarching theoretical categories or goals for students that emerged from the analysis of what was discussed. These include the notions of fostering students as *theorists*, as *critics* of their own and others' learning theories, and as *expert learners* who are able to strategically and flexibly apply learning theories as tools for meeting a variety of purposes and goals.

What follows are the results of an additional analysis in which I recoded and analyzed video data based on the three emergent themes above. The purpose of this analysis was twofold: First, I wanted to characterize the big ideas employed within the learning community, and second, to provide tools for further narrowing in on a small sample of video discussion units for an additional, more fine-grained analysis of discourse practices used in collaborative theory building and the development of ideas. My aim was to further explore and characterize the particular discourse and teaching practices within the collaborative discussions, which fostered such metacognitive capabilities and development in students. This required a qualitative analysis of discourse within a small sample of video unit discussions.

To this end, I began by identifying specific categories from the previous content analysis of the full video corpus where metacognitive thinking, processes, and capabilities were explicitly coded and demonstrated. After finding 21 categories that met this criterion, and selecting only units coded for these 21 categories, I found I had only narrowed down the sample minimally, to 133 video units. I then recoded these 133 video units around the emergent themes of *students as theorists*, *students as critics*, and *students as expert learners* for emergent categories within each theme. The results of this analysis are found in Table 23, and are further described below. I used these results to then sample eight video discussion units to serve as exemplars, and analyzed them for the types of discourse practices and processes fostering learner's development (five are reported here in the Results section, three additional units are included in Appendix H). The methods for sampling these units were presented earlier in the Methods section.

TABLE 23
Emergent Coding Categories for Students as Theorists, Critics, and Expert Learners

Students as Theorists	Frequency (# of units)
• Word learning is experiential	41
• Word learning processes are sociocognitive	32
• Word learning involves learning from expert others	30
• Word learning takes place in the context of use	22
• Word knowledge is schematic	20
• Word learning involves metalinguistic knowledge	20
• Word learning in school and outside of school	19
• Word learning takes place across different languages	13
• Word learning is incremental	12
• Words develop as a language of practice	5
• Text considerations influence word learning	4
Students as Critics	
• Some learning strategies are better than others for developing a deeper understanding or learning more words	30
• There is a best way to learn science content words/academic words	29
• Reading and/or seeing words in action better than rote memorization	25
• Problems with text make it challenging to learn words from reading	19
• Not enough time to test strategies well/unrealistic goal to learn new words in 30 minutes	17
• Teachers should use field trip strategy	9
• Which strategy is most effective depends on the person/idiosyncratic	7
• Differentiating between quantity and quality of word learning	7
• Memory/how well you remember meanings using each strategy	6
• Whether field trips are helpful/feasible depends on the context/content area	6
• Develop policy stance advocating equity in access to field trips	4
Students as Expert Learners	
• Evaluating strategies/some strategies are more or less helpful	39
• Reflect on how to improve own learning process/selves as learners	32
• Demonstrates word consciousness/word awareness in learning	24
• Flexible/strategic use of learning strategies to meet different goals	23
• See usefulness of their learning theories for themselves as learners	23
• See a need for word learning/goal-driven purpose for learning words	16
• See multiple ways to learn new words	14
• Learn across languages/using cognates and language learning schemas as linguistic funds of knowledge	14

Students as Expert Learners	
• Word learning strategies may be applied strategically for studying/and doing well on tests	12
• Using strategies to problem-solve unknown words	12
• Advocate using multiple strategies together	11
• Advocate using word learning strategies in a particular order	8
• View metalinguistic awareness as a generative strategy for learning new words (e.g. word parts, etc.)	7
• Engagement/motivational theory for word learning	5

Sampled Video Units, n=133

One of the goals of engaging students in conducting inquiry into their own learning was to create abundant opportunities for students to theorize about how they learn. Within the theme of students as theorists, I coded for emergent categories that captured the most frequent types of learning theories discussed in the sample of 133 video units. The process of students making their learning theories explicit is nested within the inquiry context as students began their inquiry by brainstorming all the possible ways people learn new words early on in the curriculum, then revisited their theories as they coordinated theory with evidence to come up with a Current Best Theory while analyzing their data.

Examples of the most frequent emergent categories under the theme of *students as theorists* include instances where students theorized about learning being experiential and situated in real life (present in 41 units), entailing sociocognitive processes or a social component to constructing word knowledge (present in 32 units), and involving learning from an expert-other (present in 30 units). Other categories included students theorizing about word learning occurring in the context of its use, and entailing schematic knowledge and awareness of connections among words, meanings, word parts, semantic field, and other aspects of metalinguistic knowledge. Still others included that learning words is an incremental process, and that it takes place both in and outside of school, across languages, and develops as a language of practice while acting or learning in a specific domain or community, and that word learning while reading can be influenced by different types of texts.

While participating in an inquiry into their own learning theories, students not only developed explicit theories about how people learn new words, they also began to think critically about what they believed were the best, most effective, or efficient ways of learning words. Evidence of students developing a stance as critics of different learning approaches was also nested within an inquiry context and aligned with steps of the Inquiry Cycle. As students began to analyze their data, they also began to evaluate competing theories and take a position based on their theories that would explain their results, making their theories objects of their own critical thinking and reflection, and ultimately taking an evaluative stance towards different learning theories previously introduced in light of the evidence from their investigation.

The most prominent coding categories for the theme of *students as critics* of their own learning processes include the ideas that some strategies are better than others for developing a deeper understanding of words (present in 30 units), along with the notion that there is indeed a best way to learn academic words in science (present in 29 units). Another prominent category was that rote memorization is not as helpful as seeing words in action or reading about them for developing an enduring understanding of a new word (present in 25 units). Students also offered numerous critical positions regarding aspects of the text found in textbooks and considerations textbook writers should take into account about their readers (but do not) when writing (present in 19 units). Finally, some other categories were less prevalent in video unit discussions, but were still interesting to note. These included instances where students theorized about how the limited time for testing each strategy influenced learning outcomes in their investigation, as well as students advocating a position based on their learning theories and evidence from their investigation in the form of recommendations for teachers, principals, and school board members, both for teaching approaches and for equitable funding for experiential learning programs.

Finally, an ultimate goal of engaging students in an inquiry into how they learn was to nurture students in becoming not only better learners, but in becoming more self-aware, self-efficacious learners, as they developed the metacognitive capabilities and awareness that they can learn how to learn. Thus, the third theme of *students as expert learners*—showing metacognitive capabilities and awareness by articulating theories about and making an explicit goal of improving as learners—is one that is central to the study.

Just as students offered many theories for learning as part of the Questioning and Theorizing step in the Inquiry Cycle, and students developed a stance as critics while engaged in Analyzing Our Data, students reflected on their own learning processes and articulated ways in which they could improve as learners in the

Synthesizing and Extending Our Theories steps of the Inquiry Cycle. Students did so while considering evidence and explanations for their Current Best Theory, along with other theories that explained patterns in their data, but especially while considering uses of their theory, who it is useful for, and how they might take what they have learned and apply it in their own lives to help themselves in the future.

Some of the most prevalent categories coded for the theme of expert learners include students evaluating strategies for how helpful they are (or aren't) (present in 39 units), reflecting on one's own learning process in learning how to learn or improve as a learner (present in 32 units), showing evidence of word consciousness and word awareness (present in 24 units), being strategic and flexible in the use of learning strategies in order to meet a variety of goals (present in 23 units), seeing the usefulness of a learning theory (present in 23 units), and identifying a goal-driven purpose or need for word learning (present in 16 units).

Summary. In this analysis of the entire video corpus of classroom discourse from both years, I found patterns in the analysis of the Word Learning Theories Assessment that bear on central ideas in the curriculum as well as bringing out new, emergent ideas that were present in discussions as well. These included students coming to see, understand, and identify purposes for learning words and how they are related to their learning goals and the context in which they are used. Students also discussed frequently the social context of learning words, articulating how communication is central for learning new words within a variety of different contexts. The variation in emergent ideas they introduced for why people learn new words showed how students working within a collaborative curricular framework developed nuanced and complex understanding of the diverse situations, purposes, and goals for learning new words.

In this video analysis, we also found that *both* school and community contexts were the situations most frequently discussed when students theorized about contexts for when people need to learn new words. The Word Learning Theories Assessment results revealed that while many students entered the curricular experience already identifying school as an important domain for learning new words (especially ELs), students came to understand that participating in communities outside of school also provides important situations for word learning. This suggests that such discussions helped to make students more aware of their language learning in outside of school contexts within a community of practice. For instance, the curricular experiences gave opportunities for students to discuss and reflect on how learning a new language, or a new profession, play an important role in learning new words.

The highest frequencies of ideas for how people learn new words discussed illustrate how the curricular experiences led to abundant opportunities for students to reflect on their own learning, fostering their metacognitive development. Frequencies were high for important ideas in the curriculum, such as that people learn experientially within a situated context of use, and that this often involves social interaction and learning from a more expert other. Frequencies were also high for emergent ideas that occurred in discussions as well. The most frequent category (in 81 units) included discussions in which students demonstrated an awareness of word learning processes and capabilities in evaluating learning strategies. In such discussions, ideas about metacognition and applying it to one's own learning were made explicit, as students considered multiple learning strategies, and the situations in which they were more or less helpful in meeting a variety of learning goals. These discussions fostered students in becoming self-efficacious learners, developing metacognition about their own learning, awareness of word learning processes, metalinguistic awareness and word consciousness, and the idea that they could apply these theories strategically as tools for diverse purposes and goals in their lives, both in the present and in the future.

Students also showed in video unit discussions capabilities in grappling with the complex and sophisticated epistemological question of what it means to know a word. Predominant ideas discussed included a more active conception of word knowledge, knowledge-in-use, as opposed to a more static or traditional idea equating knowing a word with knowing a definition. Most frequent were the ideas that word knowledge is schematic and entails actively identifying and building associative networks, incrementally and experientially, within multiple situations and contexts of use that involve learning within social interactions and often with the help of a more knowledgeable other. In such discussions, a more complex notion of word knowledge was collaboratively developed and articulated.

Finally, analysis of the video corpus revealed important overarching themes that developed as a progression through collaborative discourse over the course of students' shared inquiry. These included students acting as theorists, as critics of their own—and other's—learning theories, and as expert learners, extending their learning theories to a variety of context and purposes, and ultimately, to themselves as learners. The identification of these themes led to a further analysis and recoding of the video data, and revealed how students, early on and throughout their inquiry, were afforded a multitude of opportunities to reflect on their experiences and theorize about how they learn. Students developed and articulated experiential and social constructivist learning theories that were situated within the context of use across communities, languages, and cultures. As students progressed further in their inquiry investigation, and began to coordinate their theories with evidence, their theories became more critical. Students began to evaluate learning approaches in light of a variety of goals for learning words, as well as in light of their evolving epistemological views of what it means to know, learn, understand, and use a word within a community of practice. Towards the end of the progression, ideas developed in the learning community that showed ways in which students might put their growing knowledge and expertise from their inquiry to use, applying it to themselves in becoming more self-aware and self-efficacious learners. The ideas of reflecting and improving as a learner were made explicit as learning goals, and developed to include the idea of applying learning theories strategically and flexibly, for a variety of purposes and goals.

B. Analyses of processes that take place in the collaborative development of ideas. The recoding and analysis of video data around the three themes reported earlier (*students as theorists, students as critics*, and *students as expert learners*) not only helped to illuminate big ideas that developed through collaborative inquiry, it served as a set of tools for identifying a small sample of video for finer analysis of discourse practices and processes at work. This process, described earlier in the Methods section, entailed focusing in on one set of coding categories within the theme of *students as expert learners*, and helped me to arrive at a sample of eight video units (all from year two) that served as exemplars for further analysis.

After identifying these eight units, I developed categories for coding collaborative processes for the development of ideas within them. I identified categories that I regarded as relating to and supporting the processes of big ideas being *introduced within, developing among, and appropriated by the* learning community. Then, I analyzed each of the video units for evidence of these processes, forming qualitative descriptions that illustrate those processes. For each of the video exemplars, I also coded for teaching practices that supported or scaffolded the development of ideas central to the learning curriculum.

After analyzing eight exemplars, it was clear that there were key processes in the collaborative development of ideas that were common to all of them, and that providing fewer exemplars as evidence of these key processes was sufficient for demonstrating them. Therefore, I identified five exemplars that particularly illustrated the development of several important ideas and metacognitive capabilities that reflected key goals of the curriculum and learning environment from across the different steps of the students' inquiry (the three other exemplars are included in appendix H).

In the following section, I present analyses of these five video exemplars and the processes illustrated by each. For each exemplar, I first present the class discussion as evidence, and then provide an analysis and interpretation of processes taking place within it. Since I was the teacher, I am able to include my intentions and goals with regard to teaching practices and scaffolding moves as part of the representation of video discussion, when it is useful for understanding what took place. Together these exemplars illuminate how teaching and learning processes work together over time.

In coding for how big ideas were introduced within the learning community, I sought to understand and characterize processes by which new ideas important to the curriculum were first introduced or brought up for consideration. This included identifying the big ideas in each video unit, the origin of the idea, whether it was offered by the teacher, students, or both. In addition I coded the context in which the idea was offered, whether it was to start a discussion, or if it was a response to a prior idea, question, or example. Finally, I also characterized what followed in the collaborative development of the idea.

I then developed codes for characterizing the processes by which the class *developed these ideas further*, or how, when, and why they were reintroduced, pursued, and built upon within later discussions in the learning community. By understanding how ideas were used in different contexts and ways, one can see how concepts take shape within a learning community. I used the following analytic approach: (a) First I looked for instances where students, or the teacher, referred to or built on a previously introduced big idea important to the curriculum. I also considered whether a teacher referred to a student's idea, whether a student referred to another student's idea, and whether a student referred to a teacher's idea; (b) I then analyzed the context in which the big idea was reintroduced, as well as the purpose for reintroducing the idea into discussion. This included looking at whether the idea was building on, elaborating, or extending others' ideas, whether it was fitting into the context of the discussion or introducing a new related idea, and whether the purpose or function of bringing up the idea was to clarify the idea further, to give an example, to provide an explanation, or whether it proposed a mechanism for explaining a phenomenon; (c) Finally, I analyzed the unit for evidence of whether the idea reintroduced was offered with the goal of making an argument. This included looking for processes of argumentation, such as whether ideas were offered with the purpose of trying to come to some conclusion or persuade others of a position, whether alternative ideas, theories, or counter-arguments were considered, whether evidence was given in support of a theory, idea, or argument, and if participants evaluated alternative theories or ideas, coordinating theory with evidence to arrive at a conclusion.

In order to understand ways in which big ideas important to the curriculum were *appropriated* by students, I looked at how big ideas already introduced were being used or applied into general practice by members or groups within the learning community in thinking about their own lives. In order to understand how previously introduced ideas were used and further developed within the learning community, I analyzed whether students reintroduction of ideas involved a near-transfer in context, and also whether they applied them in new contexts (far-transfer), that is, applications to other domains of students' lives other than the original application of the idea. This included looking at whether an early idea important to the curriculum was reintroduced in order to provide an explanation of a new phenomenon or context, and whether it was the students or the teacher (or both) who applied the idea to the new context. Another aspect of the way appropriation was analyzed includes analyzing the way an idea was being re-used, such as in applying the idea in a new situation and how it may be useful, and whether participants had the idea to use the previous ideas as a tool for a new purpose or goal in another context. Finally, in looking at evidence of *appropriation and transfer*, students' Web of Inquiry project reports provided another source of data analyzed, as these artifacts documented the thinking of groups and reflect the outcome of their discourse processes and practices throughout the inquiry process.

Video exemplar 1: Critically thinking about, evaluating, and applying the idea of learning how to learn. In the first video exemplar, students engaged in the Questioning and Theorizing step of the Inquiry Cycle, brainstorming theories for learning new words. Previously, students had begun to consider how they learn new words in the context of their first learning their inquiry topic, which was to study and test different strategies for learning new words in science to see if there are more effective ways for fourth-graders to learn new scientific vocabulary. In their prior discussion, using flashcards, reading, and going on a field trip were all mentioned as possible strategies for learning new words in science that they could test. This video unit begins with the teacher posing a question to students, “Do you think that one of these strategies might be more effective than others?” to which several students replied in the affirmative. The teacher went on to suggest two competing theories as arguments for differing positions one might take in theorizing about the effectiveness of using flash cards as a learning strategy. She first offered an example of how using flash cards might not be effective, suggesting to the students, “maybe we shouldn't be spending all our time making flash cards because we're not really going to learn [the words]”, to which Jess added “or use them.” The teacher then followed this by suggesting, “Or, maybe the best way to learn them — a lot of them really fast—is by making a bunch of flash cards.”

In this piece of discourse, the teacher presents two competing ideas about flashcards: That they will not be useful because they will take time to make and won't lead to learning the words well, or that they will be a useful way to learn new words because you can be efficient and learn a lot of them really fast. This prompted Jess to share an idea, which turned out to be the first big idea introduced in this video unit:

> Jess: Like my mom's friend, like he can only speak Spanish and his mom only spoke Spanish, and he went to school and learned a whole bunch of words in English…so your life can change if you learn new things, like people say, go to school and learn new things so you can go to college, classes in college, learning different languages [there's so many] things you can possibly learn..."

The teacher then built on Jess' idea, posing a question to the class, "Is it valuable to know how to learn…What Jess was saying, is it valuable to actually know how to be a learner as you do it?"

"Yes, of course it is, that's your life!" Jess replied.

The teacher asked Jess to clarify her position and reason further, which helped to differentiate between what it means to learn new things and what it means to learn *how* to learn, asking, "Is it valuable to actually *know* how to be a learner?"

"Education is free, why not use it?" responded Jess.

The teacher followed by saying, "This is my question though. Your friend that you're talking about Jess, you can go to school and learn without really knowing how you're doing it, is there any value, is it helpful to be aware of *how* you actually *learn*?"

Students agreed, calling out, "Yeah," and when the teacher asked if someone could explain why, Jess clarified again, asking, "To learn new stuff?"

To this the teacher responded, "To learn about *how* to learn new stuff."

Jess then explained her position, saying "Oh, to learn about *how*, you have to learn about *that* because if your parents want you to go to college, first you have to learn a lot, and first a lot in school, and education, to go to college, and after learning the whole situation, you have to figure out how you do this and how you do that."

The teacher, clarifying and building on Jess' position, responded by saying, "So if you are aware of how to do it, it can help you to do it better."

Jess continued building the idea by saying, "You can not only do it faster, better, and make it easier on you, do your school work and you can go to college," developing the theory further by explaining how learning how to learn can improve you as a learner, by making you more efficient, require less mental energy, and allow you to improve your learning.

The teacher, unpacking the ideas Jess had of making learning easier, started to say, "And then maybe you can actually focus [on], with Jess interjecting to finish this statement with "Get a job." The teacher built on Jess' idea of making learning easier for yourself, explaining that, "You can save your mental energy for the things that are really hard," to which Jess added "And that are important."

Efrain, an EL, responded to these ideas, adding, "You can also make up and learn new words." After a pause in which the teacher prompted him by restating the question, “Is it valuable or helpful to know how you learn, how you do it?” Efrain responds by explaining his idea further, saying, “Like when they say something when you watch TV, and they say a word that you don’t know, on and on, and you can look it up in the dictionary.”

Building on this, the teacher added, “And then you are realizing that, you know, I am learning a word right now,” emphasizing the notion of developing word awareness and word consciousness by recognizing when you encounter unknown words in everyday contexts and uses.

Jess elaborated further with, “how do you [learn about those] words?”

The teacher added, “think about all the times you didn’t know a word and you didn’t think about whether you knew it or didn’t know it, it never occurred to you.” Building on Efrain’s idea of paying attention to unknown words and taking initiative to resolve their meanings by applying learning strategies, the teacher posed the question of whether some strategies are better than others for meeting different goals, including those which are outside of school, such as career goals, or for learning science (the question of their inquiry). In order to prompt the students’ thinking, giving them a context and a concrete example on which to take a position, she asked the students to think of a situation where they might be taking a trip in a week, and whether it would be better or more worthwhile to use a flashcard strategy or to spend some hours in a museum to learn new words. This prompted Janey to voice her position that some strategies are more “efficient,” which led the teacher to then pose the question of whether some strategies are better for learning words really well. This ended the discussion unit and became the topic of a new succeeding unit.

In terms of understanding processes for how big ideas are introduced within the learning community, as well as processes by which ideas are further developed, it is perhaps not so much a question of understanding who introduced and/or developed them, so much as it is a question of understanding and characterizing the collaborative processes at work and the teaching practices fostering them. In this example, we see ways in which the teacher suggests an idea, or takes a student's idea relevant to the topic of the class, and brings out the students' idea which modifies and alters it in multiple ways, so that students see in their own activities (their research on learning words) the usefulness of the idea for them as learners. The teacher prompts students' thinking and sharing (or developing) ideas by posing a question, which asks students to take a position on and theorize about a problem. In response to the teacher's problem posing, students initially offer ideas, which are in essence important to the activities students are working on (here, coming up with ways of learning new words in science). The teacher, recognizing an idea as important, catalyzes its development by first seeing an aspect of the students' idea, argument, or position, which has not been fully articulated or elaborated upon. Thus, one important role the teacher plays is to recognize such ideas and build on them, emphasizing and further developing the big ideas introduced or prompted by students. This often entails the teacher asking students to elaborate upon or explicate their own ideas further, or stating or restating an understanding of the students' ideas, which also prompts students to share their own elaborations. In this collaborative process, students may be thought of as developing ideas within a particular instructional context where practices and scaffolding offered by the teacher foster such theorizing.

The teacher's problem-posing began by providing a context for students to theorize, eliciting ideas from students by asking students to take a position and defend it, and to elaborate on the their position by explaining their reasoning, which often included a mechanism or process as part of their theory. This episode began with Jess, sharing an example from a family friend's experience, illustrating the importance of being a learner in your future life, and the teacher saw a way to bring forward an aspect of Jess' remarks, the idea of "learning how to learn." Jess acknowledged her awareness of how your life and future can change when you learn new things. The teacher had the students extend these ideas by asking them to take a position, and to elaborate on an explanation for their position of why and how learning how to learn could be valuable, and in the discussion they came up with ideas for making learning more efficient, easier, such as setting goals and prioritizing important learning goals.

In sharing the idea that "your life can change if you learn new things," and citing the example of a family friend learning English in school as a way of illustrating the importance of taking charge of your own learning in order to positively impact your future introduces the notion that it is not only possible, but valuable, to set goals for your own learning, and that doing so is important to your own lives and future. Jess' idea that one may have a goal of or purpose for learning, which "can change your life," suggests there is a benefit to being aware of your own learning, as well as that one can be metacognitive about one's own learning, especially with the aim of setting goals and pursuing them in order to improve your life by improving your learning.

The other important idea developed in this unit was introduced when a student, Efrain, was prompted by the learning how to learn argument to voice ways in which we can learn new words by becoming more conscious in our day-to-day lives of instances when we encounter new words and use initiative in actively applying learning strategies to understand them. He suggests taking initiative to figure out meanings of unknown words encountered in an everyday, outside of school context by applying some of the word learning strategies that have been proposed in their class discussion. In this instance, the teacher again recognized the importance of the idea, and stressed its importance for the whole class. In so doing, she drew attention to what the student's idea was exemplifying and introducing—the idea of developing awareness of encounters with new, unknown, or unfamiliar words.

This new idea was prompted by a students' initial idea in connection to the focus of their inquiry, and was introduced through the teacher posing problems in the form of questions that invited students to take a position and argue for it, and formulate an explanation for why they took the position they did. In this video unit, the teacher did this by asking if one strategy is better for learning words than another (the topic of their inquiry), and by providing an example learning goal as a context (preparing to take a trip), asking if one strategy is better for a specific situation. This introduced and implied the notion that a strategy's effectiveness or appropriateness could be situational depending on learning goals and purposes for learning, to which Janey introduced the idea that some strategies help you learn more efficiently. Finally, the unit ended—or was superseded by another unit—when the teacher posed the question, "What if we want to learn them really well?" introducing the idea that the depth of knowledge might also be influenced by the choice of learning approaches.

From these examples we see processes through which ideas develop within the learning community, including students offering ideas in response to the teacher's problem-posing, and the importance of students being given the opportunity to reflect on their own experience while theorizing. One example of a big idea developed when a student (Jess) reflected on their own family/friend's experience learning a second language in school, while another developed when a student (Efrain) reflected on his own experience outside of school encountering unknown words. Janey's idea was offered in response to problem posing by the teacher, as she evaluated learning strategies that best met different goals. Finally, it is especially noteworthy that both of the big ideas students introduced involved reflecting on learning English as a second language, and that such learning experiences present themselves as an important form of linguistic funds of knowledge from which students can draw on and theorize about.

Since this video unit is from early on in the curriculum and inquiry cycle, it is expected that much of the video unit would involve new ideas being introduced and developed collaboratively. However, ideas introduced by students in this discussion, while not explicitly previously introduced or developed, build on ideas and examples offered by other students in previous discussions where students brainstormed theories for and reflected on how they learn words. For instance, in a previous unit, the teacher presented her own experience learning a new language and using flash cards to learn new labels for known words (as opposed to learning words that are entirely new concepts) and how this could be helpful preparation for going on a trip. Jess in a previous unit applied the idea of learning words in science using flash cards to learning words in another subject area—math. Efrain's idea brings together several ideas discussed earlier, including the idea of paying attention to new words, first brought up in relation to writing, by a different student, Farima, and Jose's contribution to a class brainstorm about how people learn words, suggesting that people learn words incidentally while watching TV. Efrain draws on earlier word awareness examples and the dictionary strategy for learning science words in school, applying them to learning at home in a different context, in introducing the idea of paying attention to unknown words while watching TV and actively problem-solving by using learning strategies to determine their meaning, which is evidence of the transfer and appropriation of ideas to a new context.

In analyzing how ideas were built on, elaborated, or extended by the context of discussion, we see how Jess's idea was prompted by the context of the discussion and the question-problem of whether some strategies are better overall. The teacher problem-posing in response to an idea led students to elaborate, and the teacher building on and extending students' ideas, as well as the students building on and extending the teacher's ideas. The teacher also helped to develop ideas by clarifying them, as when she clarified Jess's idea about the goal of long-term learning by problem-posing, suggesting, "What Jess is saying…Cole, what you're thinking about is the value, is it valuable to know how to learn?"

In both ideas, students gave examples from their own lives, and proposed an idea or mechanism to explain a phenomenon or give an explanation. Jess proposed learning is valuable to your life and future goals, explaining why and how it can be valuable to learn how to learn, while Efrain proposed you could begin to pay attention and use strategies when encountering unknown words incidentally as a way to learn more. These ideas were developed through the process of students collaboratively constructing an argument. The teacher posed problems to the class, asked for theories and explanations for them, and for students to support theories with evidence. In making their argument, students appear to be goal-driven, with the purpose of making their position known. One example of this is Jess making an argument for why it is valuable to learn—and to learn how to learn—for long-term goals. Alternative contexts and goals are considered in support of students' theories for learning how to learn, and include learning a new language, watching TV, taking a test, going on a trip, learning both inside and outside of schools, in college, and for their career.

The students give numerous sources of evidence in support of their theories and ideas. Some examples include sharing experiences from their own family and friends language learning, as well as going to college as evidence of improving and changing your life, attaining goals, and pursuing a career. Learning how to do better at tests is offered as evidence of ways that learning how to learn can help your career, while experience watching TV is given as evidence of situations where you can begin to notice and learn new words. Finally, going on a trip is offered as evidence that there may be different goals for learning new words, and the idea that some strategies might be more helpful for learning them. Students evaluate alternative ideas by coordinating theory with evidence, proposing their ideas and evidence in support of them, such as when they evaluate whether certain strategies might be more helpful for certain learning goals.

Although it is still early in the curriculum, there seems to be evidence of ways students have appropriated big ideas important to the curriculum. In looking for ways big ideas are used or applied in the learning community or by individuals in thinking about their own lives, Jess, when articulating ways that learning how to learn can be helpful in achieving bigger life goals, applies a previously introduced idea to a new context. Efrain's example gives evidence of how he applies the big ideas of developing word awareness, word consciousness, and using learning strategies to problem-solve unknown words in a different domain of his life.

Finally, there is evidence in this video unit of students having the idea to use previously introduced big ideas as a tool for their own purposes or goals in another context. For instance, the idea of learning how to learn (and how to learn a new language) was presented as an important tool for long-term learning goals in college, and succeeding in life. Additionally, the idea of paying attention to unknown words while watching TV and looking them up in a dictionary suggests a view that taking the time, developing the awareness, putting forth the effort, and having the initiative to learn unknown words outside of school when incidentally exposed to them are worthwhile for learning.

Overall, we see in this unit how collaborative processes of building on ideas and examples offered by others is just as critical to the development of ideas as introducing the initial idea itself. Indeed, what is most important is the ongoing work in developing the idea of learning how to learn, and how this work is carried out. A key role in this process is the teacher's taking a student's suggestion relevant to the topic of the class and bringing out the students' discussion which modifies and alters the idea in multiple ways, so that the students see in their own activities (research on learning words) the usefulness of the idea for themselves as learners. Moreover, developing students' collaborative and group metacognition is also an important method, calling attention to the notion that they are all working all the time on *building ideas*, with ideas being the focus of their learning, not things or facts.

Video exemplar 2: Developing metacognitive capabilities in theorizing about and becoming an expert learner. In this next video unit (which follows a week after the first), students have already determined their research topic and are continuing to brainstorm theories for the best ways to learn new words in science as part of the Questioning and Theorizing step of the Inquiry Cycle. In this context, students critically evaluate competing theories, comparing classroom-based learning versus experiential learning in situ. In the precursor discussion, the class debated the merits of learning individually versus learning collaboratively, when the teacher posed a problem to the group (at the beginning of this video unit), asking the class to think of a theory that would explain the benefits of learning experientially. In proposing this question, the teacher gave an example of going to a nearby wetland known well to the students, asking, "So how does going to Hidden Lagoon, seeing in action, help us learn new words in science?" and whether going to the local wetland "to look for words, to look for evidence and clues, and experiencing it," is "better than learning in a classroom?" In further clarifying the question, the teacher gave an example of a non-experiential learning theory to compare to, suggesting students come up with a theory distinguishing between learning experientially, "in the wild," versus "reading about it," explaining, "what makes it a theory is saying why you think so."

In response to the teacher's question, Janey offered a motivational theory for learning, that seeing words and concepts in action is a more interesting and exciting way to learn new words than from reading. In order to help Janey further clarify, explain, and elaborate on her idea, the teacher asked what evidence she had to support her theory, to which Janey replied "seeing it" and "first-hand evidence." Probing further, the teacher asked, "What else is it, it's not just exciting….experience in action, first-hand evidence *is* more exciting, keep going, what are we trying to accomplish?"

Flora contributed, "How do people learn new words."

Building further, the teacher asked, "It's more exciting, so then what, if it's more exciting?" Janey developed her theory more fully by providing the mechanism, explaining how being in the environment seeing evidence "first-hand for yourself gets you interested more." The teacher, pointing this out to the class, responded, "There's your theory, see? She explained it, a logical argument, you see it first-hand, you get excited, it makes you more interested, and then you learn your new words better, so experience in action is more exciting."

Prompted by this discussion, Pablo introduced another theory for learning. Rather than arguing for one of the three learning strategies being tested in their research, Pablo had the notion of employing multiple strategies as tools for learning. Pablo's idea was to combine different learning strategies to meet the goal of learning new science words to the best of one's capability. Moreover, Pablo's theory proposed using multiple strategies sequentially, and not only was he intentional about the particular order, he provided a strong rationale for the order of their use. Pablo suggested that it would be best to first study the words by reading about them and learning from true experts, “real experts that know a ton of stuff rather than just a little stuff,” using sources available in the classroom to “learn about what we’re supposed to learn about in the classroom before we go there,” with the goal of learning more, and learning better. His argument was that this would enable one to learn even more, to get more out of their experience being in the natural environment, “so you can see everything."

The teacher, building on Pablo’s theory and the notion of the benefit of learning from a professional’s expertise, further emphasized Pablo’s point by saying, “if you learn in the classroom by reading, going on the internet, you are going to find out from people who are more expert than your teachers and parents, people who are spending their whole lives work studying something, like scientists who got Ph.D.’s in biology, more expert than teachers who spend their lives learning about how they teach and how kids learn.” Drawing in the students to make the argument, the teacher asked the class, “In the classroom you can go on the internet and…?”

“Read books,” Clara responded.

The teacher following up by asking, “But who are you reading? The work of real, live….?”

“Scientists!” the students responded chorally.

In this video unit, both of the ideas were introduced by students. The first, Janey's motivational learning theory, was offered in response to the teacher's problem-posing, and like in the first video unit exemplar, the teacher asked the students to take a position and theorize about competing theories (learning experientially versus learning in the classroom). In this first idea, the teacher's scaffolding included asking the student theorizing for elaboration and clarification (what she meant by evidence, why being excited would impact their learning) in order to help the student articulate a mechanism to explain how her learning theory functioned and to make her argument more coherent. The second idea that was introduced by Pablo, which was also prompted by the teacher's problem-posing and likely by the precursor discussion developing the big idea of a motivational theory as well, showed his metacognitive capabilities in learning how to learn. Presumably, in weighing what is the best way to learn (reading versus experientially), Pablo arrived at his own conclusion about what really would meet the goal of helping him learn the most, and this was combining the strategies and making the most of both. In this case, posing a task to students where they are asked to theorize about their own learning, even when set up for them to compare two distinct learning strategies and competing theories, proved to be thought-provoking and open enough thinking task to foster the kind of flexible and creative critical thinking where the best ways to learn how to learn can be theorized about.

As was the case with the first video exemplar, one would expect to find many new ideas brought up in this unit since it takes place during the beginning stages of students' inquiry, when they are considering different theories for learning new words. However, as was also the case with the first unit, the lines of distinction around introducing new ideas are not absolute. While a new idea introduced may be novel, at the same time it may also take into consideration or make reference to some aspect of an idea that was previously discussed. In this sense, new ideas can simultaneously be introduced into a learning community while also building on previous ideas, which germinate and migrate into the new ideas of a discussion. In the case of the important ideas from this video unit, the motivational theory presented by Janey was a novel idea, however, in the context of the discussion leading to its development, reference was made by the teacher to an EL student's previously introduced idea, Eduardo's explication of learning experientially or "seeing in action" and "keeping it real." Eduardo's descriptors for experiential learning became a "touchstone" for the class, and a part of the language of practice within the learning community, as shown in this video unit, with "seeing in action" and "keeping it real" referring to the real world application of word learning, its purpose, and goals. This process of collaborative development demonstrates how following individual students' discrete contributions to an idea isn't necessarily as important as seeing how ideas took form over the conversation, and to understand and characterize how most students took part, as the result is an idea that they *all* own.

As we see in this video unit, ideas are collaboratively developed through the processes of building on, elaborating, and extending others' ideas, both new contributions and those introduced in prior discussions, in order to fit the context of discussion and develop a coherent argument. In this process, students and the teachers can serve in multiple roles, with students responding to the teacher's prompting, with students building on other students' ideas, or the teacher extending students' ideas. For instance, in this unit we see how Janey builds on and extends Eduardo's idea of "keeping it real" from a previous unit by developing a theory that explains why learning through experience is better than other ways, with the scaffolded support of the teacher and another student, Flora. Another example of how these multiple roles are played out in collaboratively developing ideas was when the teacher built on a student's idea, extending Pablo's idea of how reading from experts in a scientific domain or field could allow you to learn more than learning from teachers or parents alone.

In the collaborative development of the big ideas of this video unit, we see how scientific argumentation is a coherent strand throughout, as well as how the teacher uses a variety of prompts and questions to engage students in crafting a strong, coherent argument. This begins with the teacher problem-posing on the outset, setting the stage for students to theorize about competing theories and asking them to take a position and argue for one being more beneficial or effective in light of the goal of learning well (deconstructed in early discussions to mean developing a deep, complex, and multifaceted knowledge and understanding of a word and its concept).

In this video unit, we see how Jane offers an idea to explain the phenomenon of how best to learn new words in science, when she proposes that learning experientially is best. She explains the mechanism at work in her theory by suggesting that going out into nature is more exciting, and therefore more motivating, which she predicts will help students learn more by making them more interested. In making an argument, Janey has multiple purposes, including explaining how her position helps people learn well, as well as communicating the conclusion she has drawn with others. Janey, with the support of scaffolded questioning and prompting by the teacher, proposes a logical argument in her theory, driven by the goal which the teacher emphasizes by asking the whole class, "what are we trying to accomplish here?" In considering whether and how alternative theories are introduced or considered, the teacher asks students to theorize from the beginning by positioning reading about a topic in class as an alternative theory to learning experientially. While no one takes up the idea of providing a counterargument for why reading would be a better approach than experiential learning, Pablo presents a spin-off theory with a counterargument for why reading is valuable embedded within it. He suggests a theory that is consistent with and which incorporates the experiential theory, but which combines the reading approach with experiential learning. He goes on to provide an explanation and mechanism for why it should be ordered a certain way and how making use of multiple strategies in this way can make use of the best of both and be the best way to learn, explaining the value of learning from experts by reading before learning experientially in situ.

While the students in this video unit begin to evaluate alternative ideas, such as why learning experientially may be the best way to learn and coming up with alternatives like the idea that combining strategies might be better, they are not yet coordinating theory with evidence to arrive at a conclusion. This is expected since the students are still in the beginning phase of their inquiry process with the task of theorizing and coming up with a research design that they could then carry out to test their theories. While students could have offered anecdotal evidence to support their theories, as was brought up in support of experiential learning in prior discussions when students reflected on learning while on a field trip to a local aquarium, the discussion unit ended and a new discussion superseded in which the class fleshed out the three learning theories and accompanying strategies students came up with which they would focus on as a class in designing their inquiry. In so doing, students recalled which individual students (both ELs) had brought up some of the original theories for their inquiry, with Eduardo attributed as suggesting the idea for learning experientially and Angélica for proposing a learning theory using flash cards and studying definitions from a dictionary.

Finally, in analyzing this video unit for evidence of ways students may appropriate prior ideas, such as in putting them to use and applying them in thinking about their own lives, this is again less expected in the early stages of inquiry.

However, while some students may not suggested an idea to explain a new phenomenon, give an example in a new context, or give evidence to support a prior idea, there is one example where aspects of appropriation are apparent. Pablo, in offering his theory, demonstrates aspects of appropriation of prior ideas by using them as tools for his own purposes or goals, flexibly using and applying them. This is remarkable since it illustrates how students, when given the opportunity to think about ways that they learn (including entertaining other students' learning theories), can put those ideas to use in their own lives while simultaneously offering their theories as thought-objects themselves for others to develop in the learning community, enacting a form of appropriation in their theorizing, and with the whole learning community benefitting.

Video exemplar 3: Demonstrating word consciousness and metacognitive capabilities while constructing an epistemology of word knowledge and learning. In the third video unit, students have already hypothesized, made their detailed plan, tested out their three learning strategies, and begun to look for patterns in their data. In the unit, the class begins by summarizing and analyzing their findings for their first set of data, which includes the class' average growth for the flashcard strategy. The teacher began the discussion by asking students to reflect on their combined results for the flashcard strategy, including the class average growth per word (which was about one column's worth of growth on students' rubric for knowing a word), as well as the average rating students had given the strategy for how helpful it was (3.8 or very close to "helpful").

In this context, the teacher posed the question to the class, "what does that say about this strategy so far, we don't have anything to compare it to yet, some conclusions we can draw from our data already?" Calling on Susie, the teacher asked, "Do you think that we can say that it is a helpful strategy? What can we already say about flashcards, based on the class average?" When Susie was unsure at first what the data suggested, the teacher summarized the data, saying "what the numbers mean here, on average students in our class moved over a whole column on how well they knew the words, shifted up a column," and asked, "Is that saying that we learned something?"

To this Susie replied more confidently, "Yeah, yeah, not a lot, but yeah." The teacher asked students to show by giving a "thumbs up," "thumbs to the side," or "thumbs down," if they agreed, somewhat agreed, or disagreed with Susie's conclusion. Most students agreed, though some qualified their agreement, as Gage did when he said, "Not very much but a tiny bit, 1%, not very much," and to which the teacher responded, "because there was growth, but it wasn't a whole lot, I see."

This was the context that set the stage for introducing the first big idea in the video unit, which came—importantly— in the form of a question from a student. Following the teacher's acknowledgment of Gage's qualified agreement that the flashcard strategy was helpful based on the patterns in their data, Ella asked a question which grew from her own reflections on her experience using the flashcard strategy. She asked, “How is it that you learn a word and you understand what it means, you learn the word, then you understand what it means, but then you forget it quickly?”

The teacher in response affirmed that Ella’s question raised a good point, restating Ella’s position that “flashcards are helpful for learning what a word means, but you forget it really quickly.” The teacher followed by asking if anybody agreed or had a similar experience, “that you could learn a definition and study them, but don’t necessarily remember them very well?” asking, “How many of you remember the definitions of the flashcards from a week ago?” to which students had mixed replies, with most students saying “I can’t.” Following this, there was a discussion about how well the three different strategies for learning words might work for the long term, with an idea proposed that if they took the word assessments at the end of the year, they could see which strategies led to a more enduring understanding of the words.

The teacher, building on Ella’s observation, returned to the idea of coming up with a theory to explain the short-term effectiveness (and long-term ineffectiveness) of the flashcard strategy for learning words. A broader goal was having students begin to critically evaluate the effectiveness of learning strategies, which was the purpose of their research. The teacher asked students for theories for why a strategy is effective, having in mind Ella’s question. In the process of students’ coming up with their theories, new, unexpected, and important ideas were introduced.

The teacher began, “Ella’s point reminds us that these strategies, field trip, reading, and flashcards, may be useful for different…what’s the word I’m thinking of, that could finish that sentence?”

“Could be for different kinds of people,” Jess replied.

After Jess offered this new theory—that learning strategies are idiosyncratic—the teacher attempted to encourage the class to think of other ideas by providing an example to help students arrive at the idea that different strategies might be helpful for different purposes or goals, saying, “Say you may have a test the next day, flashcards may be a really good strategy if you’re taking a test tomorrow, but if you want to understand something really well because you’re really into it, you’re really interested in it, maybe flashcards and dictionaries aren’t what will help you, maybe it’s going and experiencing it for yourself, seeing it with someone who knows something more about it.”

This example prompted Jess to offer a new big idea, “If you want to study for a test and it’s kind of hard for you, you can’t find a strategy to really [get them], well, maybe you could make up your own strategy that could help you out,” With the teacher’s encouragement, Jess continued to develop her idea, saying, “You don’t have to always follow the strategies that your teacher says,” to which the teacher agreed, and Jess went on to explain, “Well, you do, you should do that strategy, and then try to make up another one that could also help you do it faster, like you’ll still get the exact same answers.”

The teacher, building on Jess' idea that one could and should manage one's own learning strategies, added, "Ultimately, if you were able to come up with your own strategies to figure out what works well for you…I think that it is important to be able to do this for yourself because your teachers are going to change, you're the one that stays the same in this world, and then it's not just taking a class, then it's getting a job, then it's doing your job and doing it well."

Jess followed by connecting this idea back to an earlier conversation about how learning how to learn from their inquiry could help them in middle school, saying, "Because we were talking earlier about how we do stuff and saying we would have to do it [right] in fourth grade and [then in] fifth grade, then when we go to [middle school], the exact same thing, then maybe you would want a different strategy instead of following the same strategy that your teacher told you…Maybe you have different strategies to help you."

The teacher emphasized Jess' big idea of actively choosing strategies, building on this idea using math as an example, explaining how expert mathematicians actively monitor and manage their strategy use, saying, "What makes a good mathematician isn't knowing a formula, it's knowing what strategies for solving a problem are really efficient and knowing not to waste your time with one strategy, if it's taking too long, give up on that, try a new strategy…exactly."

The teacher returned to the task of helping the students to arrive at a theory that different learning strategies are useful or helpful for meeting diverse learning goals. She began by suggesting that "taking a test, understanding something well, doing a job, learning words to do a job, these are all different things," then asked, "that are different, what? They're kind of like different reasons for doing something, what's another word for reasons to do something?"

"Motivation," a student replied.

With motives serving as a purpose for learning, the teacher helped them hone in further, asking, "You're motivated to accomplish, what?"

To this the student replied "Strategies?"

The teacher explained how "A strategy helps you to accomplish this…"

"They could help you accomplish a huge test," Jess added.

Finally the teacher wrote down a "G" on the board and the students chorally and triumphantly called out "Goals!" Bringing the ideas back to Ella's question which began the whole discussion, the teacher explained:

> Ella this came from you, maybe one of these strategies is not as good for remembering these words for the long-term, maybe flashcards isn't the best strategy if your goal is to really learn them over time, if your goal is to know them tomorrow for a test and you never need to know the word again, maybe flashcards is a perfectly good strategy, so maybe what we're learning is that our strategies really depend on our…?
>
> Students: "Goals!"
>
> Teacher: Our goals for learning them. Well, the teacher sets goals for us too….like your example of going to middle school and figuring out what your goals for learning are, and what strategies, and seeing if they work for you is a really good thing to do because it's going to help you, not just in school but in a job.
>
> Jess: Goals are pretty much like resolutions.

Finally, the teacher used her own teaching and job as an example, relaying how she actively monitors, flexibly uses, and manages strategies, as well as evaluates their effectiveness as a form of inquiry, to arrive at an important question for the whole class to consider, sharing:

> Teacher: When I come into a teaching day, I have a plan and I have a strategy for how I'm going to go about getting a lot done or helping you to understand how to do something, and I think about it and over time I sort of experiment and I figure out what seems to be working well. I even do a little data collection, some of the video I'm collect here is helping me and your work is helping me to know too, so I'm thinking that what Ella's point is, one we should really think about, is can we really say that one strategy is better than another, or does it depend on what our goals for learning the words are?
>
> Jess: It really depends on the goals for learning the words.

The video unit ends with the teacher asking the class what our learning goals should be for learning new words in science in school, and to consider the class' rubric delineating the incremental nature of word knowledge, using the different level descriptors from the rubric to guide their thinking, asking:

> Is our goal to use it but not to give a definition? Is it to be able to use examples and give a definition? Is our goal to know it and explain how it's related to other goals and concepts? What do you think our goals should be?

Efrain enthusiastically suggested, "I know, I know, the last one," to which the teacher, connecting back to Eduardo's idea that the rubric was a continuum showing their language development and learning goals across their lives, replied:

> And this is the one where Eduardo was like "It's like life," and I was like, these are our lifelong goals, if we could learn things really well over a long time, I don't know that we will always be able to do this, but it's a good goal anyway.

In this video unit, we see how a fourth grader's question initiates an entire discussion that is rich in theory building and opportunities for students to demonstrate metacognitive thinking and capabilities, such as flexibly and strategically using learning strategies in an active and deliberate way that supports their taking charge of their own learning. Rather than having ideas brought out from a teacher's question or problem-posing, which we have seen is a fruitful approach in prior units, in this unit, a student asks a thoughtful and observant question as she reflects on her own experience in light of the evidence the class is analyzing and evaluating. What is noteworthy here is not just that it was a student's question, and that it arose from her own process of reflecting on experience using a learning strategy while weighing the evidence from their data, but that the act of coming up with thoughtful questions is itself a sophisticated and challenging cognitive task— at any age. Ella's question, "How is it that you learn a word and you understand what it means, you learn the word, then you understand what it means, but then you forget it quickly?" shows that in the context of conducting inquiry about their own learning, particularly in an inquiry context where students are analyzing data and coordinating theory with evidence, fourth graders are capable of asking thoughtful and sophisticated questions about their own learning and memory when given the opportunity. This question prompted the teacher, building on Ella's reflection and observation, to help students construct a theory to explain Ella's experience—that a learning strategy can be helpful in the short-term, and introducing the idea that different learning strategies are helpful for different learning goals. This response from the teacher is very different than if she had just answered Ella's question with her own idea, saying something like "because you didn't learn them that deeply, you just memorized a definition" or something along those lines.

What we also see about the process of how big ideas are introduced into the learning community from prior units, and from this unit especially, is that they are not introduced by one person exclusively, but are co-constructed through a collaborative process. The big ideas of this unit were initiated by Ella's asking a question, prompted by the process of coordinating evidence with her own experience using a learning strategy. The teacher recognized in this question an important idea, in this case a theory, supported by and consistent with Ella's question as well as the data, which was important to the curriculum. With the theory in mind, the teacher attempted to lead the students to articulate and discover it (rather than telling it to them), by asking questions and giving situated examples, a process which led to new theories and new ideas that were unanticipated by the teacher, and which would not have been offered had the teacher simply explained her theory to the class.

From this video unit exemplar, we see how the teacher and student worked together to develop important ideas. Ella in some sense introduced the idea, that using flashcards leads to short-term knowledge of words, which the teacher developed into a theory, suggesting that flashcards might be a useful strategy for learning goals that are short-term, like knowing words for a test, and that different strategies can be useful for different goals. Jess then brought up a new idea, that the effectiveness of learning strategies depend on the person and that you can take charge of your own learning, making up your own strategies that will be more efficient (along with ones teachers want you to use), which the teacher further developed, adding the idea of learning to be a problem-solver, and understanding yourself as a learner and which strategies work best for you, which will help you in your future, in a job, or, as Jess adds, in middle school. Ending with the epistemological question of what their goal should be for learning new words in science in school, the teacher refers to Eduardo's idea of long-term goals embodied in the levels of their rubric ("like life," life-long goals striving for deep knowledge).

The process of collaborative development of ideas enacted in this unit entails successive building of theories in response to precursor ideas, taking the previous ideas and using them to introduce a new but related theory or idea, often with the teacher expanding student ideas into more developed theories, and naming them as theories. This involves taking an observation or reflection and developing it into a broader theory (as with Ella's big idea), further developing a theory by explicating the broader process entailed and articulating the goals (as with Jess' big idea), as well as referring back to students' ideas brought up earlier within the unit (as with Ella's and Jess') or in previous units (Eduardo's). Throughout this process, the teacher poses problems and questions requiring students to coordinate and critically analyze theory and evidence, like, "What conclusions can we draw from our data already?" "Can we really say that one strategy is better?" and "What should our goals be?"

While it is expected that ideas from previous units would resurface or migrate among the learning community in discussions taking place farther along in the curriculum, like this one, we see in this unit how ideas are referred to and built upon both from prior discussions and within a single discussion. Within the discussion, for example, Jess builds on the idea that different strategies might be more helpful for developing a deeper understanding of words with her new idea of developing one's own strategies. Meanwhile, examples of ideas from prior discussions resurfacing include that efficiency is desirable to consider when choosing a learning strategy based on one's goals (introduced by Jess in the first video exemplar), and Eduardo's idea that understanding a word and its related words or concepts is a lifelong goal.

As we have seen, teaching practices supporting the development and articulation of students' metacognition include processes central to collaboration and argumentation. Throughout the video unit, the teacher builds on, elaborates, and extends students' ideas, fitting the context of discussion, while also introducing new ideas. Another important teaching practice apparent throughout this unit is using examples. The teacher gave examples of how different types of strategies might be useful for meeting different learning goals, such as taking a test, as well as examples of ideas discussed the previous year, like testing students' knowledge of words later in the year to investigate whether different learning strategies would lead to more enduring knowledge and to discover which strategy is more helpful in the long run. The teacher gave an example of a mathematicians' process for solving problems successfully and efficiently to illustrate ways in which one may monitor and manage one's own problem-solving, and gave examples of different learning goals such as taking a test and understanding something well. Both the teacher and students gave examples of long-term learning goals, such as learning well in middle school, getting a job, doing a job, and doing it well. Finally, the teacher gave examples from her own practice as a teacher, sharing that she has goals for each lesson, that she uses these to plan and choose teaching strategies, as well as in reflecting on what is working well. At the end of the unit, she used examples from the rubric level descriptors when asking the class what their goals should be for learning new words in science.

The teacher's use of examples serves a number of purposes. In many instances, they help to make what would otherwise be challenging, abstract ideas more relatable and understandable for the students, conveying and clarifying big ideas of the curriculum, such as in offering examples of different learning goals and strategies that could help meet them. They are also used by the teacher as a tool in offering a cognitive apprenticeship approach, modeling ways in which a more expert other might use metacognitive capabilities in thinking about, monitoring, and managing their practice, as with the examples of the mathematician and the teacher describing her own practice. Finally, using the examples from the rubric descriptors supported students in considering the epistemological question and in evaluating what their learning goals should be.

Processes of argumentation form the backbone of much of the thinking processes in this unit, and are collaborative as well. Rather than having one individual construct an argument for others to consider or weigh, arguments are formed together, as students and the teacher collaborate in proposing ideas or mechanisms to explain a phenomenon with a goal-driven purpose of trying to come to some conclusion or persuade others of a position. Ella, in asking her question, sought an explanation or mechanism to explain a phenomenon of learning and memory she experienced and reflected upon. The teacher, in seeking to collaboratively build an argument with the students to address an aspect of this question proposed the new idea that the learning strategy, which had limitations, might be useful for specific situations and goals.

In the beginning of the unit, the teacher poses an inquiry task to the students of identifying and analyzing patterns in their data. She asks students early on in their analysis what their evidence shows, and encourages them to theorize about what it suggests and why, coordinating theory and evidence, saying "We don't have anything to compare yet, what are some conclusions we can draw from our data already?" We see from this example how the teacher's problem-posing sets the stage for students to coordinate theory with evidence in drawing conclusions, in order to make an argument about the helpfulness of the flashcard strategy. Following Ella's question, the teacher sought to make an argument by problem-posing, asking questions, and offering situated examples to help lead students to come to the conclusion that different strategies are useful for different situations and learning goals. Jess and the teacher both make the argument that students should take charge of creating and using learning strategies that are helpful for them as individuals to meet goals for their future. Finally, the teacher asks students to take a position on what their own goals for learning words in science should be.

As a central aspect of inquiry entails weighing alternative theories, it is important to see whether and how alternative ideas are introduced. In the beginning, the teacher introduced the idea that short-term knowledge might be useful for a particular learning goal, an alternative idea to the assumption that forgetting a word quickly is undesirable. Another alternative idea introduced by the teacher using examples and evidence is that a strategy's value depends on one's goals for learning, rather than simply accepting that some strategies are valuable while others are not.

And of course, seeking or giving evidence in support of a theory, idea, argument, or counterargument is also crucial in inquiry and argumentation, and is an important process evident in this video unit as well. At the beginning of the unit both the teacher and several students offer evidence of the limitations of the flash card strategy. Ella gives evidence that the flashcard strategy is minimally helpful, citing her own experience while questioning her own learning and memory processes, which the teacher uses as evidence to introduce and support a theory that flashcards are useful for short-term learning goals, while other strategies might be more helpful in the long run. Jess and the teacher use evidence to support a theory that one should choose strategies based on how helpful they are in meeting different goals.

Finally, this evidence is offered and evaluated while put to use in one of the most important and cognitively challenging processes of argumentation and inquiry, that of coordinating theory with evidence to arrive at a conclusion. Ella questions her own learning processes as she grapples with the evidence from the class' data and her own experience, wondering how a strategy could be helpful when her own evidence seemed to suggest otherwise. This led her to seek an explanation which launched a theory-rich, collaborative discussion in which the class co-constructed a theory, coordinated with evidence in light of different learning goals (short and long-term), and reached a conclusion, that different strategies can be more or less helpful for meeting different learning goals, such as the short-term goal of knowing a definition for a test, or a long-term goal of understanding something really well.

In analyzing this unit for evidence of students' appropriation of prior ideas, there is evidence that students have taken up, used, and applied ideas from the curriculum in thinking about their own lives in broader contexts. For instance, Jess seeds the big idea of creating learning strategies that will be most helpful to you as a learner, then considers how this can be useful in other contexts, such as middle school. Jess' idea recommends taking control of your own learning, reflecting on yourself as a learner to figure out what works best for you in order to improve as a learner, which shows metacognitive capabilities and evolving self-efficacy in learning how to learn, thinking creatively, and applying ideas and principles in new ways to domains outside of the class' inquiry context. Jess shows appropriation of important ideas of the curriculum by applying the idea of using learning strategies flexibly and creatively as a tool for her own purposes or goals, and suggesting that students create their own strategies that meet their individual needs as a learner.

Video exemplar 4: Students demonstrating growing awareness of their own word consciousness and metacognitive capabilities as learners. In this video unit, students continue to look for patterns in their data and begin to coordinate their evidence with theories while starting to draw some conclusions. The unit begins as prior units have, with the teacher problem-posing to the class, asking students to reflect on their results for the reading strategy that, this time, had the lowest results of the three strategies, and to theorize about why it was lowest, saying, "I was thinking what is interesting about reading, do you think reading is a really horrible way to learn new words?" to which the students replied in unison, "Noooo!"

This question prompted Ella to reflect on her own experience using the reading strategy, sharing, "I have a different theory. When you're reading, you don't know what page to look on, so sometimes you just look randomly, sometimes in the story I saw the word *community* and it turned out I was working on that word, and I saw a bunch of other words on the board, so now I know that I can see them all over."

The teacher noted that Ella had started to develop more of a conscious awareness of target words, saying, "So you started noticing it." to which Ella replied, "Yeah," and the teacher followed with, "Whereas before you maybe didn't know to pay attention or you wouldn't have been paying attention?" The teacher then built on Ella's idea, returning the class to the task of coming up with theories to explain their findings for why the reading strategy was least successful. By thinking-aloud, she modeled the metacognitive thinking scientists engage in as a way to prompt students' thinking, and to engage them in these very processes:

> There's a bunch of things I thought of from what you said. When you do research like we're doing and get results and see reading didn't do so well, you want to start asking yourself as researchers, what should we ask ourselves as researchers? A natural question comes to my mind about reading; I want to know, what are some different theories now? Ella, you started to say you started reading and you couldn't find a word, how many people had that experience?

Many students raised their hands in agreement. The teacher explained that, "As a researcher, scientists, we have our results, we see the missing link, we want to start to ask ourselves what explains this? Why? Why do you think reading wasn't as effective?" She then offered a possible explanation, based on Ella's reflection, that "Maybe it's because the words weren't all in the text, I tried to make sure they were all on the same theme, but maybe there was no guarantee they were all there," and prompted students to come up with alternative theories, asking "What else was difficult for you when you were reading? So there was the issue that maybe the words weren't all there…"

At this point in the discussion many students raised their hands to offer alternative theories. Gabe explained, "It would say the word, and then it wouldn't say the definition, and then you'd just be like "Argh, it's not here," and go on to the next one, like three or four sentences away." The teacher reiterated Gabe's idea, saying:

> So a couple things, maybe the meaning isn't in there at all, maybe the meaning is there … but it may be difficult to learn the words when reading because the definitions may not be there, you may read the word but it doesn't explain what it means.

The teacher then asked the students "How many of you had that happen? Ella says the word might not be there, Gabe says the word might be there but the meaning might not be there?" Counting raised hands, the teacher went on, "Sometimes it would say what the word means but it's like three or four sentences away, so it's hard to figure out when it's not right immediately after the word, in a different paragraph even. How are you supposed to remember and connect it back to that word?"

After listening to reasons why it is difficult to learn new words from reading, Efrain (an EL) offered his own idea, which was not an explanation for why the reading results were lowest. Rather, he suggested an alternative approach to use when encountering difficulties learning new target words while reading, "I think that if you look at it in the dictionary, you can read it again, or you can tell an expert what it means, and you can ask what it means." In his impromptu comment, he suggested using multiple strategies that could combine to help make the words make more sense (using the dictionary, rereading, seek out an expert, and ask someone).

The teacher followed up by saying, "So Efrain, what you're suggesting—using other strategies besides reading, so maybe reading is better for some kinds of learning words, but maybe it's not the best way to learn science words that are brand new, you've never seen them before and you don't know what they are but you can get a general sense of (them)?" The class then began recollecting all of the level descriptors in the rubric, and the teacher, looking up the last level, said, "Five was, I can picture what the word's related to and all the things it's connected to. So reading is probably good for, what, not for giving a definition…"

"Giving a word in a sentence?" a student suggested.

"Maybe it's good for giving an example?" suggested the teacher. The teacher then went on to develop her theory more fully by connecting it back to Ella's initial idea of developing an awareness of words while reading and noticing them all around, saying:

> Or if you've seen it or heard it before, maybe it's just for that first exposure, maybe reading is better for certain kinds of learning of words, like just getting exposed to them, like Ella was saying, then you start to notice them, like when the teacher is using words on the board, or Lena reading a book…

Discussion of the idea that strategic reading can help you learn new words by providing initial exposures to words fostering a beginning familiarity or general sense of the word in context, led Meggie to reflect on and share her own experience developing word awareness. She explained how:

> In after school class I learned a word *hypothesis* and I started seeing it all around town, and my parents started saying it more and more and more and more, and it was really weird 'cause I kept becoming more familiar with it.

The teacher asked Meggie how the word first came up in her conversation at home, and Meggie reported that she hadn't told her parents she was learning about the word in school, her parents just happened to be using the word, and she noticed it, an example of what was described in an earlier discussion as seeing the words "all over," in this case it was at home in Meggie's parents' conversation. The teacher expressed enthusiasm that Meggie was aware of her own developing word consciousness especially outside of school, then pursued the idea of having students analyze differences between language used at home and in school, asking the students to reflect on types of words used in these different domains, saying, "But aren't there words you use at school that you don't use at home so much?" A number of students agreed and one student suggested an example, "Like theory." The teacher built on this example in asking a follow-up question, "But does that mean you don't have any theories at home?" to which students chorally replied "Nooooo!" The teacher asked, "You just don't what?"

"You just don't say the word," Cole replied.

The teacher followed with, "You can use the word…?" and several students responded chorally with, "Ideas!" The teacher ended the discussion by emphasizing and summarizing this point, noting, "So you have theories, you're just not naming them that."

This example shows how the curricular innovation of having students conduct inquiry into their own learning creates opportunities for students to reflect in this way on how they learn and develop self-efficacy as they make the connections themselves by analyzing their own learning process and seeing how they can acquire dispositions and capabilities to improve as learners. In this unit we see students are not only developing word awareness and word consciousness, but that they are *aware* of their own developing word awareness and draw on examples of these experiences to create and critically evaluate learning theories.

The teacher set the stage for discussion, like in others, by problem-posing, asking students to draw on evidence from their data to take a position and reason about whether reading is an effective or useful strategy for learning words, presenting a competing theory by asking the class, “Do you think reading is a really horrible way to learn new words?” This prompted Ella to offer her “theory,” which became an important idea in the life of the discussion, with both the teacher and students returning to it. Ella, probably while thinking of ways or reasons why reading is *not* a horrible way to learn new words, shared how she developed and used a strategy strategically, skimming for target words, and found it helped her to notice target words "all over," on the board, and not just in text. She proposed an alternative theory for how the task of strategic reading might work as a mechanism to help learn new words. In describing how the process of skimming for words and reading and noticing target words, helped her to then notice them in other places, Ella demonstrated her developing metacognitive awareness and word consciousness. In explaining how reading strategically for new words helped her to develop this awareness, Ella proposes a causal mechanism whereby reading with a conscious and strategic purpose or goal of looking for target words can lead you to notice them in other domains. Finally, we see Ella demonstrate metacognitive awareness of how this process helped her as a learner to develop her own word awareness.

Many of the big ideas in this unit involved students reflecting on their own experiences while engaged in the process of theory-evidence coordination. For instance, Ella gave evidence from her own experience of how the reading strategy helped her, while Gabe shared an observation from his experience in order to explain the evidence for the reading strategy, that words in text don't have definitions (and meanings are explained farther away). Later, Meggie reflected on and shared her experience hearing the word *hypothesis* at home and in school, and brought up the idea of how language use can vary across domains in one’s life, that developing awareness and word consciousness can help you notice important words around you, and that concepts may be the same even while language to describe them may differ.

Rather than explaining why the reading strategy was the least successful, Efrain suggested using other strategies and gives reasons why. What was intriguing about this turn in the discussion is that Efrain was moved to think of what would be a better alternative strategy to learn the meanings of the words. In his impromptu comment, he suggested using multiple strategies that could combine to help make the words make more sense (“look at it in the dictionary, you can read it again, or you can tell an expert what it means, and you can ask what it means). The teacher then builds on this idea, developing it into a theory for why reading might be better for certain learning goals, such as providing a first exposure or building familiarity with a word versus Efrain's idea that it might be better to learn brand-new scientific words by using the dictionary or asking an expert.

In this video unit, we see evidence of how both the teacher and students refer to or build on prior ideas that have been offered in the class that are important to the curriculum, and how they are developed and related to each other through collaborative discourse. The idea of beginning to notice words around you had been brought up earlier in the curriculum, particularly when students were theorizing about ways to learn new words, and were thinking about how environmental print helps you to learn words by noticing words around you, such as on signs while walking down the street. Gabe's idea that words in text don't have a definition right there had also come up during the theorizing step, when the idea for problem-solving unknown word meanings using context clues was offered. However, many of the ideas were developed collaboratively in this unit with both the teacher and other students bringing up and building on others' ideas. For instance, the teacher builds on Efrain's idea that other strategies are better for learning new scientific words, by suggesting it depends on your goals and that reading is a strategy that can be good for a specific goal of developing familiarity with a word by just having first exposures to new words, and also referring to Ella's idea that reading can help develop word awareness.

The teacher at the end of the video unit refers back to Ella's initial idea in developing her own theory and drawing a conclusion that:

> Maybe reading is better for certain kinds of learning of words, like just getting exposed to them, like Ella was saying, then you start to notice them, like when the teacher is using words on the board, or Lena's reading a book.

Finally, Meggie's example of noticing words, while brought up in earlier discussions, was clearly prompted here by Ella sharing her experience of noticing science words in other contexts, an experience which Meggie shared. While these ideas may have been introduced into the learning community earlier in the curriculum as students developed initial theories about ways of learning new words, this video unit shows how students were consistently using the ideas by applying them to their own experiences and sources of evidence. In this video unit, the ideas themselves appear to have been offered or to have occurred to students because they were relevant experiences that seemed to fit the context of the inquiry task of coordinating theory with evidence, and not necessarily because they had been introduced before.

Many of the processes of how ideas develop and germinate in the learning community revealed in earlier video units are present here as well. For example, the teacher, in recognizing the kernel of an earlier idea offered by a student, frequently *emphasizes the idea and builds on it, elaborating and extending the students' idea* by developing it into a more coherent theory. One case found in this unit included when the teacher applied Ella's idea of reading being helpful for developing word awareness to the new context of identifying which word learning goals this might be useful for. In another case, the teacher elaborated on Efrain's idea of other strategies being better for learning new science words by suggesting reading is useful for providing initial exposures to a word, and proposing how that alone can be useful. The teacher also built on Meggie's idea of developing word knowledge across school and home contexts by having students reflect on their own language use in these different situations to notice differences in the way words are use in each, fostering the development of students' metalinguistic awareness. This helped students see that, while the same thinking processes could be at work in both domains, the language used to describe the processes may differ, with school being a place where more formal academic language is used.

Another common practice the teacher used was to *clarify students' ideas*. This served multiple purposes. In some cases, the teacher would clarify a student's idea in order to understand it better or to help them develop their idea further, as when Meggie shared her experience with hearing the word *hypothesis* and the teacher asked, "Was that a word they were using at home anyway, or were you telling them some of the things you were learning in school and they started to try to use it at home more with you?" In other cases, it was a way of emphasizing an important idea or aspect of an idea that a student voiced which the teacher wanted to stress to the whole class, such as when she said to Ella, "So you started noticing it…whereas before you maybe didn't know to pay attention?" She also clarified as a way of making sure that she had understood a student's idea correctly, so that in building upon it (seeing how the students' idea prompted a new one of her own), she was doing so while accurately understanding and representing the student's idea, as was the case with Efrain's idea when she said "So Efrain, what you're suggesting, using other strategies besides reading is better for some kinds of learning words, but maybe its not the best way to learn science words that are brand-new?"

Ideas also develop collaboratively within this unit through the use of examples. While in the previous video unit the teacher *offered examples as a strategic teaching practice*, in this unit we see it is the students who offer examples when sharing ideas in response to the teacher's problem-posing or questioning. For instance, Gabe offers examples of ways or reasons why reading was a difficult strategy for learning new words in science, including that it was hard to find the target words in the text and that the definitions or meanings weren't always there, while the teacher added that explanations of words weren't always near the word. Efrain gives examples of strategies that could be more helpful than reading for learning new science words, and gives examples that explain why the other strategies could be more helpful. Meggie offers an example of her own developing word awareness across school and home domains, and when the teacher asks the class if there are words they use in school but not at home, a student gives an example of the word *theory*. The teacher, when she did offer examples, referred back to previous examples which came from students and used them in developing or articulating theories, such as referring to Ella's noticing words while reading and on the board, and Lena's noticing words while reading a book.

Finally, processes for developing a theoretical argument are central to this video unit discussion, as with the others, and often provided the stimulus for students' important ideas, particularly the process of coordinating theory with evidence to arrive at a conclusion. For example, Ella proposes an idea or mechanism to explain a phenomenon when she presents her experience of how reading might be useful or helpful for learning new words. The teacher, building on Ella's idea, also proposes a mechanism to explain why reading might be better for developing word awareness through initial exposures rather than for learning definitions and specific word meanings. Ella shows evidence of making an argument, with the purpose of trying to come to some conclusion on the position of whether reading is horrible or not, when she suggests "another theory" as evidence of how reading strategically can be helpful for learning and noticing words. Alternative theories are introduced and considered from the start, when Ella seeds the idea that, contrary to what their data suggest, reading is not a poor way to learn new words, proposing a counter-argument (using her own experience as evidence) to challenge the idea that reading is ineffective. No one challenged the idea that reading is best for initial exposures to words and developing word awareness by suggesting the alternative theory that reading might be better for developing a deeper understanding of words and concepts by reading from experts, which was an idea introduced by Pablo in an earlier unit. However, a student did suggest that reading is good for seeing words in context, "giving a word in a sentence," connecting reading to the epistemological goals for word knowledge described by the middle level of the class' rubric for knowing a word (I can use it, but I would have trouble giving a definition).

In terms of *evaluating alternative ideas*, the teacher asks students to evaluate their evidence in coming up with alternative ideas to explain why the reading strategy wasn't effective. The teacher also asks students to evaluate what learning goal the reading strategy might be most suitable for in learning new words. However, it is Ella who proposes and evaluates an alternative theory when she proposes that the reading strategy is helpful, sharing her theory to explain how reading strategically can be helpful for developing word awareness both in reading text and other areas, drawing on her personal experience as evidence to support and inspire her alternative theory.

The teacher begins the discussion by asking the students for a theory, idea, or argument to explain the evidence from their data for the reading strategy being least effective. In offering their ideas in response, the students use evidence to support their ideas in making their arguments throughout the video unit, beginning with Ella offering her experience as evidence of how she developed word awareness while reading. Gabe cites his frustrating experience reading for target words as evidence of why reading might be the least effective strategy tested, and Efrain gives examples and an explanation as evidence to support his idea that other strategies might be more effective than reading for learning brand-new science words.

This video unit, which takes place later in the students' inquiry research, provides additional evidence of students' *appropriating and applying important ideas* of the curriculum from previous units, with more examples of ways students applied big ideas to their own experiences, goals, other areas of their lives. For example, Ella applied an idea introduced earlier in the curriculum of developing word awareness while reflecting on her experience with using reading as a strategy for learning words, and analyzing data from that strategy, when she expressed how reading with a purpose of learning words helped her to become aware of target words in the text, but to also notice them "all over." In particular, she used the previous idea of making a counter-argument for ways in which the strategy is helpful and applied it in identifying her own growing word awareness. The idea she introduced is one which is especially metacognitive, as it involves an awareness of her own growing word consciousness and how it is developing across situations, rather than being specific to a given task in school. What is interesting in Ella's comment is that she applied the notion of developing word awareness and word consciousness to a new context in explaining a new phenomenon (arguing for the value of the reading strategy they tested as a way to learn new words). She also showed how she was able to apply her idea of developing awareness of target words and use to meet her own current learning goals, showing evidence of her growing self-efficacy in learning how to learn, by realizing such awareness is a valuable learning tool for her to use and apply elsewhere, saying "So now I know I can like see them all over." Later in the unit, Meggie appropriates and makes use of Ella's idea of developing word awareness and word consciousness in learning new words when she applied the idea to learning across different domains in her life. She remarked that her parent's conversations at home is a context for noticing uses of the new academic language introduced in school, and she recognized her own developing metalinguistic awareness, saying "I kept becoming more familiar with it."

These examples show how students made use of important ideas developed earlier in the curriculum and applied them in the new context of *analyzing evidence in light of their theories*. The inquiry context of analyzing data and coming up with theories that explain their findings provided the impetus for students to spontaneously take big ideas developed weeks earlier and apply them. Ella's idea of paying attention to and noticing words was introduced earlier. She reintroduced it here while providing a counterargument for why reading is valuable even though it showed the least growth in their data. She applied this idea as a mechanism for explaining how reading strategically for target words could help you learn new words. Efrain, as a way to help explain their findings, referred back to the previously introduced idea of learning from experts in offering alternative strategies to reading for accomplishing the goal of learning new scientific word meanings.

Perhaps most importantly, the examples from this video unit demonstrate that students *use prior big ideas as tools for their own purposes or goals in another context*. As mentioned earlier, Ella's comment "So now I know I can like see them all over," suggests she is starting to notice and pay attention to words deemed important in multiple contexts for her own learning. Finally, Meggie, reflecting on her experience and process of developing word awareness, described how she "kept becoming more familiar" with a scientific word, suggesting she is aware of and can describe processes for her own developing word consciousness in learning across the different domains of her life, and that such awareness can help her learn, apply, and use the academic language from school in a variety of contexts.

Video exemplar 5: Engaging in critical reflection and strategic application while considering the value and usefulness of their learning theory. This unit takes place after students had finished summarizing and analyzing their data. The overall topic of the unit is a discussion of what their findings suggested, as they prepared to create a Current Best Theory in their small groups, and to provide an explanation for their theory based on their evidence, as well as think of uses of their theory. This led to a discussion of how to make their research results convincing to others, and how scientists accomplish this.

The unit began when the teacher posed a question to the class, referring to their results and findings:

> What does this mean as far as what we should do— the reason we're doing research—to know the best ways to learn words in our lives? What do you think this tells us? Is reading a bad, unproductive thing to do? What can we conclude from this?
>
> Efrain (an EL) suggested, "Try a different strategy?"

The teacher, picking up on Efrain's idea that as a learner you can choose and use different strategies, responded with a well-established previous idea, saying, "Maybe using more than one strategy is useful?" She then turned the students' attention to the evidence from their research to look for support for this idea, asking, "Did we find that we grew in more than one strategy?"

Cole answered, "We learned that field trips are good for teachers if they want their kids to learn some words, they can take them on a field trip to a place with a lot of examples, and maybe with experts to help."

The teacher, seeing and building on Cole's idea of stipulating when their theory could be useful and why, went on to add, "For teachers who don't go on a lot of field trips to learn science and see things, this could be evidence to say, look, those of you who aren't going on field trips, it's valuable for your students, it's fun, students find it valuable…" The teacher then referred to their data, pointing to their self-assessments in which students wrote their evaluation of the strategy and their perception of how helpful it was using a five-point scale, saying, "Using this— [points to self-assessments] these are your own reflections— students find it helpful, valuable, to help them learn, teachers find it valuable too…"

At this point there was a turn in the direction of the discussion, when Meggie introduced a new idea, asking how they might be able to convince others of the accuracy of their theory. She asked, "Well, what if they ask you, like, make more of these things," (pointing and referring to their word assessment data from the different trials for each strategy), "…for reading, learning on a field trip, go together to learn on a field trip…"

The teacher clarified Meggie's idea by asking, "You mean if we were presenting our data and people didn't believe it?" Meggie affirmed this was her meaning. The teacher restated the question, posing it to the class, saying, "Good question, in science, you are researchers, you present to a community, how are they going to be convinced that this is accurate?"

"You could show them the assessments," Cole suggested.

The teacher emphasized this point, pointing out that the assessments are a form of evidence, saying, "I could show them the evidence."

Flora (an EL) then suggested, "You can show them what we have done, like the [rubric]."

"You could show them videos," Cole added.

It is noteworthy how at this stage in their inquiry research, the students were introducing new ideas into the learning community that are relevant and pertinent to the steps of the Inquiry Cycle which they now found themselves concerned with. In this unit, students introduced new ideas for the stage of inquiry they were entering, namely thinking of uses of their theory, for whom it is useful, and how to convince others of its accuracy, credibility, and usefulness. The ideas students introduced take into account the role of coordinating evidence with theory in making an argument to convince or persuade others. Specifically, Meggie introduced the idea of how to use evidence to persuade others successfully (and that this is indeed something one should be concerned with as a researcher), by asking the question, what if teachers want more evidence or "want to see more of these." This is especially important because what Meggie is doing in asking this question is taking on the role of the critic, asking for more evidence, and in so doing pushes the learning community to scrutinize their own work and to find multiple sources of evidence that could work together to provide confidence in the strength and predicting power of their theory. The students not only think critically about their own work in constructing an argument for others, they see and articulate the value of their learning theory for themselves as learners. In response to Meggie's new idea, other students, including Flora and Cole, began to think of the various sources of evidence that not only support their own evolving learning theories, but that are sources of evidence which could be shared to convince others. What is remarkable in the examples these students offer is that they go beyond suggesting their results on the word assessments as evidence from their data, and include the ideas of transparency and validity in how their data were assessed. This came up with Flora's idea that knowing the rubric scale for assessing results on the word assessments and self-assessments would be important for others to be convinced, and Cole's idea that the videotapes of their inquiry could accomplish this as well.

In addition to new ideas being introduced in this video unit, there were several previously introduced ideas that were referred to and built upon. These included

Efrain's idea that you can "try a different strategy," which in this context suggests the notion that you can choose learning strategies based on how effective they are, choosing one that is more effective than another, and actively manage and use strategies flexibly. This led the teacher to reintroduce the idea that using more than one strategy can be useful by asking the students if their evidence supported this idea. Cole, continuing to build on the idea of actively choosing strategies, began thinking about for whom this could be useful and how a teacher might use multiple strategies, noting that if teachers "want their kids to learn some words, they can take them on a field trip, to a place with lots of examples, and maybe an expert to help." The teacher further developed this idea by playing the role of a critic, responding to teachers who might be skeptical of this learning theory, providing an argument for why teachers should go on field trips if they aren't already doing so, with the learning theory for vocabulary development at the core of the argument. In providing a rationale for this position, she drew on several previously introduced ideas, including Janey's motivational theory from the Questioning and Theorizing step in their inquiry, that field trips are more exciting and engaging for students which will help them to learn.

Several key processes are evident in the unit that help set the stage for students to reintroduce earlier ideas for consideration and further development. As we have seen before, the teacher posed an alternative idea to the class and asked them to take a position on it as a way to elicit students' theories and ideas. For example, in response to the teacher's question about what their data "tells us," "what can we conclude from this," and whether reading is an "unproductive thing to do" for learning new words, Cole offers a response which suggests that one can be strategic, and assert a form of agency in their own learning by selecting learning strategies. Processes of building on, elaborating, and extending others' ideas are demonstrated throughout the video unit, and are used in collaboratively developing an idea or mechanism to explain a phenomenon, such as in developing a theory for the best way to learn words suggested by their evidence. For instance, after Cole suggested trying another strategy, the teacher asks if their data show that multiple strategies are useful, to which Cole presented what he saw as the conclusion from their data, collaboratively building and proposing a theory for teachers to use.

Another strategy used throughout the collaborative development of ideas in this unit by both the teacher and students was offering examples to communicate ideas and help make an argument. This unit began with the teacher using examples as part of her strategy to elicit students' ideas, asking them to take a position on what the implications are from their study, using their reading strategy results as an example. Cole gave an example of a learning theory supported by their research, that teachers could use if they wanted students to learn more words, while Flora and Cole offered examples of forms of evidence from their research which could be used to persuade teachers and others of the accuracy of their findings and Current Best Theory.

Clarifying ideas and developing a scientific argument in support of a theory are also important processes at work in the collaborative development of ideas in this unit. The teacher clarified students' ideas as a way to understand, make explicit, highlight, and draw out important ideas from students. For instance, when Meggie introduced her question, asking what if the teachers wanted to see more evidence, the teacher clarified and restated Meggie's question, while emphasizing the bigger underlying question and posing it to the class, asking how they could convince others that their theory was accurate? This question itself is central to constructing a scientific argument. Meggie took on the role of a critic, challenging the learning community for ways to provide evidence to convince a skeptic, a process the teacher just modeled by addressing a hypothetical teacher being skeptical of going on field trips, and presenting a persuasive argument for their learning theory. Following the teacher-as-skeptic's lead, Meggie introduced a whole new idea by asking, what if the audience wants more evidence to be convinced of their theory? In so doing, the role of evidence in their inquiry has evolved. Evidence is not just used by students themselves in critically evaluating their theories, but has expanded to include multiple sources that can be used to make a strong persuasive argument for convincing others. When the question of what sources of evidence would convince others was posed to the class, students Cole and Flora offered forms of evidence to convince a skeptical audience of the strength and accuracy of their theory by going beyond their data to include assessment tools, rubric scales, and video of their inquiry process, building the ideas of validity and transparency into their evidence and their argument.

Overall, in this one video unit, evidence is used in multiple ways. First, we see how the teacher used evidence when problem-posing to students, asking what was learned from the data using the reading strategy results as an example. Both the teacher and Cole offered evidence in support of the argument for why teachers should take students on field trips to learn new words in science. And towards the end of the unit, students offered further evidence that could be cited to convince others of their Current Best Theory, to show that there is a strong body of evidence in support of it. Evidence offered in support of a theory, idea, or argument, was given in response to requests made by both the teacher and students. For example, the teacher asked the students, "Did we find that we grew in more than one strategy?" Meanwhile, Meggie, by asking what if teachers asked for more evidence, was herself asking for further evidence to support an argument for putting their Current Best Theory to use. Finally, students used evidence in evaluating alternative ideas, coordinating theory with evidence to arrive at a conclusion. It was in light of their evidence that students suggested the strategy that was most helpful or useful, and in offering alternatives to reading, suggested that they "try a different strategy." Meggie evaluated whether there was enough evidence to convince others of Cole's conclusion, with Flora and Cole supplying further evidence in support of the theory, collaboratively developing the theory into an argument for teachers to put the theory to use and offering evidence for why they should.

While in this unit we didn't see specific examples of ways students appropriate, use, and apply ideas in new contexts or domains of their lives, we did see them making some connections and applications that are new within the domain of their theory's context of learning new words in school. After Efrain offered the idea of being able to actively choose strategies based on learning goals, Cole offered a new perspective, about thinking for whom the theory might be useful. With a new audience in mind, he proposed that teachers could choose a strategy strategically with the goal of helping their students learn new words. In their research up until this point, the emphasis had been on students themselves learning how to learn. In looking beyond how their research was helpful for themselves as learners, they considered a broader audience who would benefit. Cole and the teacher constructed an argument that teachers should be strategic in choosing strategies that will be helpful for their students, providing a rationale for why and evidence to support it.

IV. Analysis of Students' Web of Inquiry Project Reports

Students in their small groups carried out the steps of the Inquiry Cycle using the Web of Inquiry software, the teacher, and each other for support, documenting their group members' thinking for each step along the way in their Web of Inquiry project report. This included the theories that they wished to test, along with their research questions, and hypotheses, a detailed plan for their investigation, their data in the form of tables and graphs, and summaries of their findings. From there, students in their groups, drawing on their results, went on to craft their group's

Current Best Theory, as well as to provide an explanation for their theory, evidence to support it, problems and limitations of their theory, and further research they could conduct informed by their inquiry.

The purpose of analyzing the inquiry project reports is to understand more about students' theories and their metacognitive awareness and capabilities as learners embodied in them. This analysis includes examining both the initial theories students had following classroom brainstorm sessions and discussions early on in the curriculum, and their more developed and coherent theories which students constructed after conducting their investigation and which they developed through coordinating their theories with evidence from their research. To that end, I coded four sections of the project reports for each of the nineteen student groups which best captured students' evolving theories over the course of their inquiry. These four sections were *Our Theories, Our Current Best Theory, Explanation for Our Theory, and Further Research*. For each of the groups' theories, I first coded whether multiple theories and accompanying learning strategies were offered (versus offering only one main learning theory or idea). Next, I coded for whether students demonstrated flexible or strategic use of learning strategies. Some examples of this included coding for whether students theorized that a particular set of strategies should be used in sequence, or that a specific strategy be used for a specific purpose or goal, and whether students explicitly stated in their theory that learning new words entailed using multiple strategies. I also coded for whether students offered an explanation for their theory (as they were prompted to by the Web of Inquiry software), whether they cited evidence in articulating their theory without prompting, and if the students presented their theory in the form of an argument, explicitly advocating for a position or drawing a conclusion. The results of this analysis are summarized in Table 24 below.

Table 24
Content Analysis of Group Web of Inquiry Project Reports

Coding Category	Frequency in Initial Theories	Frequency in Current Best Theory
• Offers multiple theories and learning strategies	12	13
• Shows flexible or strategic use of learning theories and strategies	4	11
• Offers an explanation for their theory	18	19
• Provides evidence as part of their theory	5	18
• Frames their theory in the form of an argument	10	16

N=19

Offers multiple theories and learning strategies. Overall, when students in their group wrote their theories in the Web of Inquiry, they more often than not included more than one learning theory or idea, both in recording their initial theories for investigation (12 groups) and for their Current Best Theory (13 groups). This is not surprising for groups' initial theories, since the directions of the Web of Inquiry software for the step *Our Theories* asked students to come up with multiple theories. However, in writing their *Current Best Theory*, students were directed by the software to come up with one Current Best Theory to explain their findings. Additionally, because of the nature of students' research questions, which were comparing and evaluating competing learning theories and their strategies (e.g. flashcards versus field trips), one might expect the students in their Current Best Theory to focus on the one strategy that was most effective (writing a Current Best Theory explaining why learning experientially with a more expert other in situ is valuable and effective). Indeed this was the case with the six groups that did not offer multiple learning theories and strategies as part of their Current Best Theory. Given these considerations, it is in fact noteworthy that over half the groups (68%) offered multiple learning theories as part of their Current Best Theory. More noteworthy are the ways in which these multiple theories are developed within each groups' Current Best Theory, and the metacognitive awareness and capabilities students reveal in them.

In looking at the theories themselves, we see the influence of ideas offered in precursor whole class discussions on group's initial theories. Students in their groups wrote theories about how people learn new words that included ideas that came up in brainstorm sessions, such as learning from family members through conversations and while taking family trips, and by paying attention to environmental print around you, like when you are walking around town. Many initial theories included ideas from discussions as well as ideas about the three learning theories and their accompanying strategies which they would go on to test in their research, as the following examples illustrate:

Turtles Group – Our Theories:
We also think you can learn new words from friends or family, and seeing them around town because signs in shop windows might have words you've never seen or heard before, and family and friends will talk about things using words you've never heard before, and you learn them from either asking or listening to the sentence as people are talking and also use the context of the sentence to figure out what they mean.

Rabbits Group – Our Theories:
Our theories are that people can learn new words from their family. Our theories are that people can learn new words from their family by talking to them, and reading with them, and going on family trips with them. You can also learn new words by reading, which is good for your reading ability and [it] has more information about the word, like examples. Flashcards can be good for using them as a helpful way to learn new words because there are many words and if you memorize them and what they mean then you can learn that word which is new to you. You probably will understand the words better if you keep reading them.

Shows flexible or strategic use of learning theories and strategies. The coding category identifying evidence of flexible and strategic use of learning theories and strategies showed the most change from students' initial theories to their Current Best Theory. Only 20% of groups demonstrated such metacognitive thinking and capabilities in their initial theories, while 60% did so in their Current Best Theory. In coming up with their Current Best Theory, more groups offered multiple strategies despite the fact that they were prompted to give only one theory. It was often the case that students acknowledged the benefits of all of the learning approaches, even if evidence showed one was more effective, and groups even explicitly included the ideas of using and applying multiple learning strategies depending on one's goals, situations, or to use them in a particular order, to best learn new words.

Students with Current Best Theories coded for this category often suggested using a particular strategy or approach for a particular purpose, often while explaining why reading was the least effective strategy according to their data, and in offering alternative theories that predict its usefulness. In one example, a group came up with a particular learning goal and purpose for when they thought reading would be most useful, writing "but the worst one was reading. Maybe you should read about science when you want to make or invent something, or you can invent your own thing and words." Another group also considered alternative theories for why reading might be useful, acknowledging that "reading might be important sometimes when you need it," going on to explain how for instance, if it is raining and you can't go on a field trip, reading is an alternative strategy you could use. This same group went on to articulate a situated experiential word learning theory that went beyond field trips, connecting back to ideas discussed earlier in the curriculum. In the following example, we glimpse ways in which students show awareness of their developing word consciousness as they have come to see opportunities for learning new words are all around, "in your life":

> We think that going on a field trip with an expert is the best way to learn new words. Because the expert knows more than you of the word and the expert can give you an example and you can know the word better. And you can also see it in real life and you would know it by now, so go on a field trip to learn scientific words. We think that the best way to learn scientific words is going on a field trip with an expert because the expert has more experience and information and you can learn more about the word that you don't know. You can see it in action and experience it. We can see it and feel it, feel the texture, and we could ask the expert how do you use it if you don't know ….Field trips

> are the best way to see words in action, and feel it, and see how it describes the thing you are discovering. It doesn't only have to be in field trips, it can be in your life, if you don't know a word and you go to a store, and you can explain to the expert what you are looking for, and the expert might know the word and he can give you the thing you want. You can see it in the situation.

The examples above show how in groups' demonstrations of flexible and strategic use of learning theories and strategies (demonstrated in their Current Best Theories), students include –and have appropriated—several ideas previously introduced in class discussions. These include ideas of learning from family and friends, in school and outside of school, from situated contexts (such as learning from taking trips and environmental print), and from many discussions in which alternative theories for why reading was least effective were considered.

In this group's Current Best theory below, we see another previously introduced idea appropriated by a group in their Current Best Theory, as they suggest using multiple learning strategies in a particular order, with the order coinciding with the order of the strategies' effectiveness according to the evidence from their data. Another previously introduced idea used in providing an explanation for the group's Current Best Theory in this same example includes how learning by "seeing in action" outside of school is motivating:

> We think that when you're learning words in science, we should go on a field trip because it got the highest score on learning new words. Then we should use flashcards for the words we didn't know after the field trip. Then, we would read about the words and learn a little bit more. Our theory is about why going on a field trip got the highest score. We think that it got the highest test score because it was really fun and that way the kids would want to do more research. Also another theory is that when we were looking at the lagoon

> we saw most of our words in action. We think field trips are the best for learning new words in science because when the students see the words in action then they will be more motivated to learn more words. That way they will develop their knowledge! It is also fun for the students to learn words out of school. It is also fun because if you don't know what something that you found is, such as creatures, plants and other things, then you could look at it under the microscope and observe it.

The groups that demonstrated flexible and strategic use of learning theories and strategies for their Current Best Theory often presented strategies to meet a particular goal or for a specific purpose. For instance, one group suggested choosing a learning strategy based on learning goals dictated by certain conditions and constraints, such as having a limited amount of time, and for a particular purpose, such as learning definitions of words, writing that "Flash cards are better than reading when you only have a short amount of time, and so flash cards are going to be the best word learning strategy to learn definitions." Another group suggested using multiple strategies based on the evidence from their research, and went on to explain why they thought one was better than another, and how certain strategies led to a deeper understanding of a word, similar to the ideas that came up in an earlier class discussion about what it means to know a word, when the class created the rubric for assessing their word knowledge. The group wrote in their Current Best Theory:

> Our current best theory is that when students learn words in school they should probably use the field trip strategy. But also the flashcard strategy worked almost as well. We think the field trip strategy worked better because we really got to understand the words, while the flash card strategy worked because if you guessed incorrect they would give you the correct definition.

In another group's Current Best Theory, they recommend using all the strategies, basing their theory on the evidence from their research, and using their research as the basis for selectively choosing a single strategy to use if necessary:

> We recommend to use all the strategies because they all help students learn the definition of words, and field trips did the best so we recommend that if you can only go on one go on a field trip. Flash cards work well because you see the word and definition over and over again. Field trips work well because you see the word in action. Reading works OK because you see the word in a sentence as long as the text isn't too difficult.

Some groups in their Current Best Theories showed an awareness that all strategies are helpful, but that their use depends on the situation and context, such as whether one has the ability to see the words, which was an idea introduced in earlier discussions (the idea that some things are harder to see in nature than others, like the Spectacle Bear in Peru). One group, for instance, suggested that teachers should "choose a field trip where you can see all the words you're trying to learn in action." Another group noted this as well, and advocated for a more additive approach to managing your learning strategies, using them all while paying attention to the situation in which you use field trip as a strategy, as it is context-dependent. They wrote:

> Our current best theory is that field trips work well for learning new words because you can see the words in action, but you have to choose the right place or else you can't learn the words. Reading and flashcards are helpful too, but don't do as well as field trips so maybe people should go on field trips to learn new words more often in addition to reading and flashcards.

Offers an explanation for their theory. Of the other categories coded for, almost all of the groups (18) in their initial theories, and all of the groups (19) in their Current Best Theories, provided an explanation for their theory. This is not surprising as, again, the students are asked to do so in the directions for each of these steps in the Web of Inquiry software, and the teacher in whole class and small group discussions for both steps emphasized "explaining why" as well.

Providing evidence as part of their theory. Providing evidence for their theory, however, showed the greatest change from students' initial theories to their Current Best Theory. Five groups (26%) referred to some form of evidence in their initial theories, such as examples from their own experience, while all but one group referred to evidence in their Current Best Theory. This is not unexpected since students, in offering their Current Best Theories, are basing them on the evidence from their research. However, what is noteworthy is that while students were not prompted to refer to evidence from their research in their Current Best Theory, all but one group—95% of the students—chose to do so. Many of the earlier examples show how students referred to their evidence, such as in saying things like "field trips did the best," and "We think that when you're learning words in science, we should go on a field trip because it got the highest score on learning new words." Just as was the case in the video exemplars where the teacher offered evidence to students and asked for students to come up with theories to explain it, students showed how they appropriated the use of evidence as a springboard for reflecting on and theorizing about their own learning.

Frames their theory in the form of an argument. Finally, Web of Inquiry project reports were coded for ways in which students appropriated processes and practices in developing a scientific argument. This category also showed change from students' initial theories to their Current Best Theories, with more groups in their Current Best Theory framing their theory in the form of an argument with the explicit purpose of convincing or persuading someone of their theory and conclusion drawn from their research. Given that the purpose of the investigation (and students' theories) was to predict and explain the best ways to learn new words in science, it is not surprising that about half of the groups (10) framed their initial theories as recommendations for what someone should do to learn new words. However, the number of groups who did so in their Current Best Theory increased considerably to 84% (16 groups), and they made their audience even more explicit. In some examples, the audience they spoke to were teachers, for example saying, "field trips are a very good way to get your students to learn new words that they haven't ever learned before," and "so if you're looking for a way to get your students to learn, then you should choose a field trip where you can see all the words you're trying to learn in action." In other examples, students are speaking to other students, offering advice for learning. In this next example, the group develops a more idiosyncratic learning theory, explaining why using all three strategies are important:

> So each theory is true for some people….the theories are all worth the time, so don't just try the best, because you might not do great on one, you might do better on one, but you need three theories to try. So to this point, just try three theories, don't worry how well you did because then you may have been hoping for a theory to win and it might sink and not do well. Reading you may learn different words than you want, but you still learn new words.

Discussion

This study is an investigation of an approach to teaching and learning in which, students theorize about and investigate their ideas for how they learn new words. Through inquiry into their own theories about how people learn, students develop a greater awareness of strategies for learning, how to orchestrate and use them flexibly and intentionally as tools for learning, and why these might be valuable or useful to them in meeting a variety of goals in their lives.

Results from this research suggest that fourth graders can indeed develop and articulate theories about how they learn words, and they can develop, test, and refine their theories. This occurred with the scaffolding and support of the teacher and of the Web of Inquiry software, and in the context of a curricular approach in which students' theories for learning words were analyzed and reflected upon as objects of their study. This approach enabled students to develop knowledge of scientific inquiry, general metacognitive skills, and approaches specific to learning vocabulary. Students became more 'expert learners' with increased awareness of how they learn, and developed dispositions of word consciousness. By increasing awareness and self-knowledge of learning, students were able to think about how to apply learning theories in their lives, influencing their feelings of agency in the role they play in their own learning.

In this study, important metacognitive capabilities for learning how to learn were developed in the context of students' theorizing. Students, through the process of conducting collaborative inquiry were able together to, construct experiential, situated, and sociocognitive learning theories, as well as theories about how interactions with others who have more expertise can scaffold learning. Students grappled with sophisticated questions, such as those which adult researchers take on, as they constructed an epistemology for learning words, and for learning in general. The body of evidence herein shows that fourth-graders can collaboratively contemplate, debate the merits of, and articulate a general learning theory for learning how to learn. They also actively make decisions and implement learning strategies as tools for attaining their own purposes and goals.

The curricular and pedagogical approach in this study contributes a valuable model of social constructivist instruction that fosters students' metacognitive development. It also serves as a model of instruction that is particularly effective for fostering metacognition among students from culturally and linguistically diverse backgrounds. Engaging students in this type of learning, when students are still forming and acquiring an academic identity in school, is particularly important.

In this work, we have seen how fourth graders can develop sophisticated metacognitive understandings about their own learning. Many of the theories expressed by these fourth-grade students were consistent with research on vocabulary learning and acquisition. These included ideas about how reading plays a role in exposing one to new words, the usefulness of context clues in text, the importance of having a close proximity between words in text and their explanations or examples, and the incremental nature of word knowledge and learning (e.g. Anderson & Nagy, 1991; 1992; Miller & Gildea, 1987; Nagy & Scott, 1990; 2000; Scott, 2005). Furthermore, there was significant growth in the number of theories students expressed in response to the question, "Why do people learn new words" Learning through collaborative inquiry into their own theories of how they learn promoted students' developing metacognitive awareness of the purpose for learning words.

The research questions guiding this study included:

1. Does a collaborative inquiry-learning environment in which students form and test their theories for learning new words facilitate the development of students' metacognitive capabilities?
2. How does such an instructional environment foster the development of these metacognitive capabilities?

Development of Metacognitive Capabilities within a Community of Learners

An overarching goal of this research project was to help students become self-efficacious learners. Attempting to meet this goal involved helping students develop metacognitive capabilities as learners, and knowledge and capabilities for learning.

By conducting inquiry into their own theories of how they learn, students developed self-efficacy, learning by developing ideas and theories about how to improve as learners. They developed a repertoire of specific strategies to use as tools for learning, and used them flexibly to meet a variety of goals. In addition to inventing their own strategies, students developed sequences for applying or using the strategies, and identified various purposes and rationales for when and how to use them. Some students theorized about and came to see themselves as being individual learners with their own idiosyncratic ways of learning, suggesting that they discovered the value and importance of coming to know oneself as a learner, including what processes and strategies work for them as individuals.

As part of their inquiry process, students saw the critical role that their own theories about learning played in their experiences as learners. They saw how their initial theories about learning words drove the entire inquiry process. They began by coming up with multiple theories during the beginning steps of the Inquiry Cycle. They developed more coherent, sophisticated theories through the process of testing their initial theories, analyzing their results, and coordinating their theories with evidence from their inquiry. Finally, as an important consequence of conducting such inquiry into their own theories of how they learn, students developed knowledge, skills, and capabilities as learners and how to improve as learners, which are useful in any learning context. Students also became more aware that they may employ strategies as tools for meeting a variety of learning goals, including those others have set for them, and perhaps more importantly, goals which they set for themselves.

Engaging in collaborative inquiry into how they learn words provided a context for students to reflect on and theorize about ways in which languages and their use differ within and across the multiple domains of their lives. They also became more aware of when in their lives they encounter new words and how they learn them. Developing such word consciousness may have the potential to impact their learning in many areas of their lives (Scott & Nagy, 2004).

The results of this study provide evidence of how the curricular environment and pedagogical approach have supported the overall goal of nurturing students in becoming self-efficacious learners. In light of the analyses of data reported, I return here to theoretically important principals which emerged from the analysis of video and which may be used to describe students' learning experiences and their outcomes. A prominent and vital aspect appears to be that, in conducting inquiry into their own learning theories, students had opportunities to think and act as theorists, and as critics, where they thought deeply about their own and each other's ideas, and, as expert learners, who refined their theories in light of their critical thinking about their own learning, and applied ideas to themselves as learners.

Throughout the results of this study, there are many examples of rich and diverse theories developed by the students. Many of these consisted of sociocognitive learning theories, including ways in which people learn in school and outside of school and how these contexts differ. In some cases, they also theorized about sophisticated notions investigated by prominent scholars, such as how people learn from participating, both directly and indirectly, in social contexts, even theorizing about such notions known in the field as learning through legitimate peripheral participation and third party observation, and by "listening in" (Lave & Wenger, 1991; Rogoff et al., 2003; Rogoff, 1990).

Other theories that students offered were about the epistemology of word knowledge, showing how fourth graders are capable of arriving at theories prominent in the research literature. For instance, students characterized word knowledge as being able to put words to use in different kinds of situations (knowledge-in-use). They articulated how they developed such knowledge and expanded upon it by seeing how words and word parts are connected, and how they are related to their understandings, experiences, and prior knowledge. In one example, a student, Ava, referred to an idea introduced by a classmate, Allan, who described how words are learned "everywhere in the world." Ava then introduced a new idea, how learning a new word for a known concept is like learning a label, which is different than learning a whole new concept (Graves, 1986). This is not only an important distinction in the research literature on word learning, it is valuable knowledge for teachers to be aware of and to make use of in planning vocabulary instruction. In this study, it was a student who arrived at this idea, and introduced it to their learning community for others to make use of as well.

There are other examples of how students theorized about concepts important in the research literature. Ava suggested looking at how infants learn new words, while Allan, Eduardo, and Tiana theorized about how reading aloud and interacting with siblings could provide a context for studying the acquisition of language. Allan explained how “It's a theory,” that people “mainly learn from people talking about a word,” and described how problem solving and third party participation serve as situations for learning new vocabulary. Another student theorized that “you are going to learn the words that are most important to you, that you hear a lot,” and went on to share how ‘no’ was her first word, “probably because I used to pick my dad's flowers and he would tell me no.” Other students followed this by sharing with great animation what their sibling’s first words were, and why. In year one, while completing the last step of the Inquiry Cycle “Extending Our Theories,” students engaged in a rich discussion in which they offered a number of theories that students could go on to develop and test. They also thought of studying their own families as a site for their research. Students responded very enthusiastically to the notion that they could theorize about ways they could act as social science researchers studying their own families and the processes and roles that contribute to their language learning.

The topics discussed and theories constructed when students applied a critical lens to their own thinking and learning process were diverse, and were reported earlier (see Table 23). Importantly, while students were acting as critics or critical thinkers, many of the students’ emergent ideas are related to the epistemological notion of what constitutes knowing a word, and what types of learning lead to a deeper understanding of a word and how well one knows it. For example, the most common coding category for students as critics was for the idea that some learning strategies are better than others for developing a deeper understanding of words, and that rote memorization is less helpful for developing an enduring understanding of a new word. Students also theorized that developing different aspects and depths of word knowledge might benefit from particular learning strategies. For instance, definitions might be best learned using the flash card strategy, while seeing how words and ideas connect and building associative networks for words might be best developed through learning experientially.

Overall, evidence from this study suggests that engaging students in discussions in which they theorized about the nature of word knowledge and how it is acquired and demonstrated in a variety of situations, encouraged students to think critically about more traditional conceptions of word knowledge, such as equating knowing a word with knowing its definition. While the origins of such critical thinking about the epistemology of word knowledge may lie in the process of students co-constructing a rubric early on in the curriculum for assessing levels of word knowledge for their own research, it seems that students' evolving epistemological ideas about word knowledge became important in their evaluation of learning strategies. Students frequently put their ideas about the incremental nature of word knowledge to use while developing theories about when and how certain strategies might be helpful or useful for learning a particular aspect of word knowledge for a specific reason, situation, or goal. This occurred most often while students were thinking critically about the evidence and learning outcomes from their own study, coordinating their evidence with theories to explain or predict such results.

When students used the Web of Inquiry, they were prompted to critically reflect on and consider the limitations of their research. Students were critical about the impact of how much time was actually allotted to using each learning strategy they were trying out (reading a science text, using a dictionary to make flash cards, going on a field trip with an expert to learn experientially), and questioned how learning outcomes might have been different if there had been more time. Furthermore, students were also asked to consider alternative theories for why the least effective strategy *was* least effective. Many interesting discussions in which students adopted a critical stance developed in the context of understanding and explaining why the reading strategy was the least effective of the three learning approaches tested. In some of these discussions students were critical of textbook writers, empowered by their own inquiry research, experience, and results. For example, students expressed the ideas that textbook writers might be out of touch with their audience, with writers assuming knowledge of infrequent words, and/or using too many infrequent, unknown, or difficult words without providing an embedded explanation for them or giving appropriate context clues to allow inference of meaning. One student even demonstrated a critical awareness of the purpose and motives behind poor textbook writing, suggesting that textbook writers could be inexperienced, or just trying to finish writing too quickly due to a deadline or wanting to make more money.

Finally, an important aim of the curricular experience was for students to see themselves as capable of improving their own learning, through actively managing their own learning theories and strategies and making use of them in a flexible and strategic way in meeting a variety of learning goals. The analysis of video exemplars, which focused specifically on how students' theories and metacognitive capabilities are applied to their own learning, provided evidence of ways students became more self-directed and self-aware learners, who theorize about how to improve their own learning. In addition, examples from the emergent coding categories in the video analysis showed how students' theorizing and critical thinking were important in developing ideas about ways in which one may improve as a learner.

Students demonstrated metacognitive capabilities in their thinking about how to employ a variety of learning approaches strategically for meeting different learning goals. For example, after critically examining the depth of word knowledge achieved through the use of certain learning strategies, and finding certain strategies were better than others for developing different types of word knowledge, students applied this notion in developing theories about when, why, and how best to make use of a repertoire of strategies for their own benefit. This is worthwhile, as students in this context learned that they have the capability to actively manage and apply learning strategies for a variety of purposes, which can extend beyond those for school. They also learned they have the knowledge and executive functioning to be intentional in using learning strategies to meet goals in a variety of situations beyond learning words. This is particularly important, given that schools are now charged with meeting the goal of producing ‘expert learners,’ who know how to direct their own learning processes, due to the increasing knowledge demands of society and the workplace in the 21st century. Since no one can absorb in school everything they will need to know in life, and with technology taking over low-level tasks, workers need to be able to think abstractly and learn new skills (Bruer, 2000; Brown, Ellery & Campione, 1998).

After becoming critical of learning strategies utilizing rote memorization, students began to consider situations where such an approach is still useful. For instance, rather than discounting rote memorization altogether because it does not foster a more multifaceted understanding of a word, students theorized that certain types of learning strategies, such as those which value memorizing definitions for the short-term, are better for preparing to take a test, while others might be better for developing deeper knowledge and understanding of words. Such insights are valuable, as there are situations while learning in school, in the workforce, and in life, when such knowledge or approaches are needed, useful, or practical. We have also seen how students began to contemplate which of their theories and strategies would be best suited for developing different aspects of word knowledge, as they theorized about not only when such strategies might be useful, but also how they might be used together, and even about the order in which they are used. In developing a critical stance towards the common (and limited) conception of word knowledge equating knowing a word with simply knowing it's definition, students became savvy in realizing that there is indeed a place for such knowledge, and that different learning goals might call for differing depths of word knowledge. Developing awareness and capabilities such as these, seeing learning strategies as tools to use strategically to meet a variety of goals, is not just valuable for students' success in school, but could also be beneficial in securing the types of degrees and credentials necessary for their future employment, and for their success in the workplace regardless of the profession.

There is also a body of evidence herein that shows that students developed an awareness of word learning processes through their participation in the curriculum. We have seen how students have drawn on and reflected upon these processes while critically evaluating learning strategies, and applying their own critical theories and outcomes to themselves as learners. Moreover, we have seen numerous examples of the sophisticated and nuanced thinking students engaged in while thinking about themselves as learners and thinking about their own thinking. For example, students articulated not only the value in learning how to learn, but the value in—and specific ways to go about—putting theories to use for themselves, and not just for teachers.

Students' ideas often migrated back into later discussions, serving as 'touchstone' ideas or theories, with the teacher referring back to them to emphasize a big idea of the curriculum. Some of these included: (a) experiential, situated learning with a more expert other leading to a deeper understanding of a word, (b) becoming a flexible and strategic 'expert learner' by using multiple strategies in a strategic order, (c) applying strategies yourself as a learner to meet your own goals later in school and life, even inventing your own strategies, and (d) that being "aware of how to do it," can be transformative, changing one's life and helping one to attain big goals for one's future, like going to college.

Other aspects of why developing as an expert learner is important came out when students were thinking about how their learning theories might be useful for meeting their own learning goals. Although the entire curriculum took place in school, the nature of their inquiry and their theories encouraged thinking beyond school boundaries, and ultimately impacted the ways in which they came to see the different areas of their lives as sites for learning new words. In particular, students developed word consciousness and an awareness of how word learning takes place within and across the multiple domains of their lives—including home, school, community contexts, and across the different languages they use in each. After participating in the collaborative inquiry curriculum, students—and ELs in particular—came to see outside of school and community contexts as sites for learning new words in addition to school. Furthermore, students articulated and theorized about when and how they might apply learning strategies in situations outside of school when they might encounter unknown words, and why particular strategies might be more appropriate to use than others in a particular situation. In addition to the value such metacognitive capabilities have for learners in any field, at any stage, this kind of theorizing shows the type of creative problem-solving that is nurtured by theorizing about actively learning how to learn and putting such theories into practice.

Efficacy of the curricular innovation for students from culturally and linguistically diverse backgrounds. The curricular and pedagogical approach of conducting inquiry into one's own theories of word learning was effective for all students. In looking in particular at its effectiveness for students from culturally and linguistically diverse backgrounds, there are some important results. In their Word Learning Theories Assessment pretest, ELs more often than their EP peers regarded school as a domain for learning new words. Not one EL offered an outside of school or community setting as a place where they would need to learn new words. This changed dramatically following their participation in the curricular innovation.

Both ELs and EP students' overall view of word learning became more sociocognitive, complex, and multifaceted, as students together reflected on and considered how they learned new words across the domains of their lives, seeing how their ideas and experiences served as funds of knowledge for everyone. The diversity of students' experiences and ideas that were brought up, especially by ELs, enriched the entire experience for all the students. As results from the Word Learning Theories Assessment revealed, ELs began to see their own language learning experiences as valuable for their own learning process, as well as for their monolingual peers. The idea of learning across languages was introduced early on by several ELs, as they reflected on and described their experiences. Students shared how they learned new words from visiting family members, while traveling to other countries, and in helping a family member or friend who was learning English as a second language.

While pre- and post-test results for the Word Learning Theories Assessment showed that all students benefited from the experimental curriculum, there was a significant differential impact of the curriculum on ELs. Results from the comparison classes showed that ELs receiving the standard curriculum actually decreased on the posttest, identifying even fewer theories than on the pretest, while their EP classmates showed only minimal growth. Engaging students in an inquiry into their own theories of how they learn new words in science not only was shown to be effective for all students, it was even more so for students from culturally and linguistically diverse backgrounds.

Pedagogical Processes and Practices Fostering the Development of Metacognitive Capabilities

Some key pedagogical processes, enacted within the pedagogical context of conducting shared inquiry into students' own learning, can be inferred from this study. One of the ways in which the curricular environment supported students in becoming self-efficacious learners was by giving students opportunities to be theorists. Students recognized early on that their ideas about how they learn were not only welcomed, they were central to the entire curriculum. Students experienced sharing their own theories about how they learn, hearing those of their classmates, and seeing how those theories were then considered and developed in the larger learning community. They saw how the teacher, in whole class and small group discussions, supported students in developing or communicating these theories for the entire learning community to understand, build upon, clarify, respond to, and even test through the inquiry process. Likewise, students saw how these theories were taken up and developed in later discussions as thought-objects by their classmates or the teacher for a variety of purposes, such as developing them further, considering counterevidence and alternative theories, as well as using them to explain and understand evidence from their inquiry.

Unlike curricula in which there is predetermined content that students have to learn and a variety of activities or lessons designed to convey that content, in this experimental curriculum the students experienced being theorists and having their theories guide the curriculum. This type of curriculum is unusual in schools, even in science, as many "investigation" based approaches often include directing students to follow a set of instructions for conducting an experiment or testing a research question, then having students reflect on what they observed to derive theories from their observations. In such approaches, students are intended to arrive at specific theories once the data are collected, and students' own prior knowledge and initial theories are not valued as being central to the learning process.

Making students' prior knowledge, experiences, and theories central to learning throughout the inquiry process was critical to students' developing theories and metacognitive capabilities. Engaging students in reflecting on their own language learning, a process they all had experience with, catalyzed students' metacognitive thinking and reflection as part of their theorizing process. It seems that the inquiry curriculum thrives when students think about a wide range of experiences and ideas for how they learn new words. Having students with diverse backgrounds and experiences in learning is highly beneficial when students are learning new forms of academic language and vocabulary within a content area through such inquiry processes. The variety of ideas and theories offered by students from culturally and linguistically diverse backgrounds enriches the learning experience for everyone. Results show that all students benefited from theorizing about how to learn academic language, the language of school, and content area vocabulary in science. Moreover, students who have experience in learning new languages, and whose first language is not the language used most often in school, stand even more to gain from this curricular approach, as the results reported herein demonstrate.

While the generation of multiple theories for predicting and explaining a phenomenon was encouraged and practiced throughout discussions at all stages of the curriculum, students' critical thinking while evaluating and refining their own learning theories became more prominent as they progressed through the Inquiry Cycle. Students refined their learning theories and became critics of their own and each other's learning theories through the process of *coordinating theories with evidence* from their research. As is evident in the analysis of video exemplars, considering alternative theories or explanations for outcomes found in their data was an important part of the learning process and was supported by the teacher's problem-posing, particularly in the steps of the Inquiry Cycle in which students analyzed their data and came up with a Current Best Theory and Other Theories that also explained their results. Pedagogical moves made by the teacher included initiating a discussion in both whole class and small group settings by proposing a theory and asking students to critically evaluate it in light of their evidence, to make an argument for or against it, or to offer a competing theory that was consistent with and which would also explain the results. The teacher would also bring up evidence from their research and ask the students to theorize in providing a variety of alternative explanations for the results they found.

Processes of coordinating theory with evidence in building a scientific argument often led students to collaboratively construct theories in which the purpose or utility of strategies were regarded more flexibly depending on the learning goals they sought to achieve. Through collaborative discussions, students and the teacher probed ideas for explaining evidence, and considered or responded to each other's ideas, theories and capabilities. This often occurred in conversations where a number of alternative explorations were offered and the purpose or goal of learning was examined, with students theorizing about ways of flexibly using multiple strategies sequentially, orchestrating them as tools for learning to meet a variety of purposes and goals.

The teacher's own metacognitive reflection and knowledge of inquiry served as a resource for her to draw upon in scaffolding learning through the inquiry process, using strategies like questioning, problem-posing, thinking aloud and modeling, in helping her students to collaboratively construct a comprehensive scientific argument for a larger learning community, and to question the purpose or motives of using a particular strategy for meeting a given learning goal. This underscores the benefit of teachers having a strong understanding of the processes of scientific inquiry and argumentation. It is by making use of this knowledge in the moment, for instance while recognizing and responding to students' thinking by asking questions, posing a problem, asking them to consider a situation, or to theorize by providing an explanation for some phenomenon or evidence, that the teacher serves as the more expert-other scaffolding students' process of reasoning.

Finally, the process of taking a critical stance in evaluating learning strategies within collaborative discourse led students to develop more sophisticated theories demonstrating capabilities of expert learners. By considering their evidence for which strategies were most and least beneficial and weighing the usefulness of the strategies, students recognized that it is not so much a question of which strategy is best, but rather the usefulness of strategies could be situated, and dependent on the learning goals of the individual learner. By collaboratively and critically evaluating strategies, students co-constructed more sophisticated theories for learning in which learning strategies were more generally regarded as tools which could be used flexibly and strategically for a variety of purposes and goals. As students refined their theories towards the end of their cycle of inquiry, they developed more nuanced theories that showed awareness that there are multiple strategies that can and should be chosen to be used with consideration for one's own purposes and goals, and that this extended into all areas of their lives as learners, in and outside of school.

Teaching practices fostering self-efficacious expert learners. From this research, we see how the teacher played an important role in fostering students to become more self-efficacious learners, with metacognitive skills and capabilities to manage learning strategies flexibly and strategically, and capabilities for applying them in a variety ways for meeting diverse goals that they—and others—have for them in order to be successful in their lives. This included helping to expand students' metalinguistic awareness and word consciousness, supporting students in becoming more aware of the multitude of situations and ways in which they learn new words, and showing them how to critically evaluate which learning strategies are most appropriate for meeting their various goals.

In this curricular approach, the teacher facilitated a process by which *students* constructed knowledge about learning new words, which consisted of their developing initial and then more refined theories, sharing their own theories for learning, and then collaboratively evaluating them through the course of their shared discourse and inquiry. In fostering such a learning community, the teacher acted as the expert, modeling the kinds of reflective and metacognitive thinking students engaged in, and theorizing herself as a member of the learning community, utilizing a cognitive apprenticeship approach in her teaching. Ultimately, the teacher's goals included fostering conversations and inquiry learning activities where students learned by putting ideas to use, building off each other's ideas, including her own. Teaching principles, practices, and scaffolding moves all supported this vision of fostering students in becoming more self-efficacious learners. The curricular approach was for students to be conducting collaborative inquiry into their own theories for learning new words, while the teacher provided students with the knowledge, skills, and processes for inquiry as tools for evaluating their different learning strategies.

Some clear patterns emerged in teaching practices and processes fostering this type of growth in students' thinking. These included the teacher's posing problems as a way to set the stage for students to reflect on their own learning, asking them to reflect on, argue for or against, or to come up with a competing theory for learning in light of their evidence or a given perspective. The teacher also placed students' experiences at the center of the curriculum and learning, helping them to draw on their experiences in multiple domains of their lives as a valuable source for theorizing. Later, in coordinating theory with evidence, the teacher had students reflect on their individual experiences in learning new words, including word learning strategies they evaluated in their inquiry research and ways they learn words in real life, to see which experiences aligned with or supported a particular theory for learning they developed.

When the teacher introduced important ideas, they were not separate, discrete items to be memorized. Rather, they were ideas to be collaboratively developed and entwined with precursor ideas, considered as topics for inquiry, and posed to students in the form of problems and questions to consider, such as through coordinating theory and evidence and making an argument. Often, important ideas were introduced by students in response to teacher's problem posing within the inquiry context, and the teacher recognized, emphasized, developed, and built on those kernels. The teacher modeled forms of argumentation and encouraged student reasoning by asking questions that led students to coordinate theory with evidence, to reflect on their own learning, beliefs, and experiences, and to explain or predict phenomenon that were consistent (or inconsistent) with the evidence from their inquiry. Students showed evidence of a form of appropriation of ideas and theories when they developed them and wrote them down as a 'Current Best Theory,' which included an explanation for their theory as well as evidence to support it. The teacher modeled scientific processes while thinking aloud, and in such an inquiry process, there is usually no one right answer. She positioned herself as another participant, sharing her thinking, and making metacognitive processes explicit, developing these as central in discussions so in each discussion unit, a scientific argument was co-constructed.

The teacher was strategic and deliberate in developing, using, and referring back to certain student ideas and examples as "touchstone" ideas, building on them to further develop big ideas within the curriculum, such as Eduardo's experience learning a new word while attempting to purchase a computer game as a touchstone example of situated word learning. She also used touchstone examples in developing a language of practice among the learning community throughout the curriculum, such as referring back to the group discussion about what it means to really know a word deeply, referring to deep word knowledge as knowing a word "like knowing Ocean Side Carnival," which came to mean being able to picture a word and all of the things it is related to, developing a schema for a word based on one's first-hand knowledge and experience. When referring to student ideas, the teacher also often clarified her understanding of them by member-checking ideas students had. For instance, she would restate them and ask the student, "Was this what you meant?" Finally, the teacher made her own teaching processes and goals, as well as the goals and processes of scientists, explicit for students, and by letting the students "in" on these, she introduced the notion that what she was doing is what they could do too.

Learning in the Twenty-First Century: Vocabulary, Inquiry, and the NextGen Science and Common Core State Standards

There are several noteworthy contributions from this study, for both theory-building and practice, with regard to designing learning environments, the scaffolding of teaching and learning within them, and for considering how to assess student learning and capabilities.

Understanding how to design and support more teachers in creating and using this kind of curricular and pedagogical approach is especially timely and important, as is understanding how to assess these kinds of student learning outcomes and capabilities, given the introduction of two new sets of standards in the United States, both of which are supported by and aligned with the curricular innovation advanced in this study—the Next Generation Science Standards (NextGen) and the English Language Arts Common Core State Standards (CCSS). These standards, which are currently being adopted widely throughout the United States, have teachers and curriculum developers grappling with creating and aligning curriculum and instruction to meet them. Inquiry knowledge, processes, and practices, such as reasoning skills entailed in coordinating theory and evidence, constructing an argument, and considering the usefulness of one's theories are critical to both sets of standards. For example, the NextGen Science Standards include three dimensions, *Practices, Crosscutting Concepts,* and *Disciplinary Core Ideas/Content,* with inquiry knowledge, processes, and practices central to the *Practices* dimension, evident in the description found on the NextGen Science Standards website, in which it says:

> The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like "skills" to emphasize that engaging in scientific investigation requires not only skill but

> also knowledge that is specific to each practice. Part of the NRC's intent is to better explain and extend what is meant by "inquiry" in science and the range of cognitive, social, and physical practices that it requires…scientific inquiry involves the formulation of a question that can be answered through investigation.[6]

Meanwhile, The Common Core State Standards are described on their website as focusing on, "developing the critical-thinking, problem-solving, and analytical skills students will need to be successful," with a particular goal of helping prepare students to be successful in higher education and to enter the workforce, "to ensure students are prepared for today's entry-level careers, freshman-level college courses, and workforce training programs," and are "designed to prepare all students for success in college, career, and life by the time they graduate from high school." In the English Language Arts, these standards are described in this way:

> The skills and knowledge captured in the ELA/literacy standards are designed to prepare students for life outside the classroom. They include critical-thinking skills and the ability to closely and attentively read texts in a way that will help them understand and enjoy complex works of literature. Students will learn to use cogent reasoning and evidence collection skills that are essential for success in college, career, and life.[7]

The type of inquiry and reasoning practices in this study speak directly to these standards. For instance, the inquiry practices include questioning and theorizing, as well as coordinating theory with evidence in order to make inferences or discuss 'Current Best Theories. This entails weighing and critically evaluating evidence in light of one's theories, to determine not just what is possible, but what is

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[6] www.nextgenscience.org/three-dimensions
[7] www.corestandards.org

most plausible when answering a question about a text that requires interpretation and inference (see White, Miller & Borge (2015), for a study in which students successfully implemented collaborative inquiry processes while studying and analyzing literature). Research with older children and adolescents offers substantial evidence that students face difficulty in coordinating theories and evidence, especially when evidence is complex and there are a number of theoretical alternatives (Kuhn, 2011).

Moreover, in addition to developing students' critical thinking, analytical thinking, and reasoning skills, the Common Core State Standards stress the importance of vocabulary learning and acquisition, particularly for content-specific and academic words, such as those encountered in science. Vocabulary development itself is found in several different strands of the CCSS for English Language Arts. These include the reading strand for literature and informational text, the literacy strand for history/social studies, science, and technical subjects, and the language strand. The importance of vocabulary learning across content areas and of content-specific academic vocabulary are emphasized in the CCSS:

> This normal process of word acquisition occurs up to four times faster for Tier Three words[8] when students have become familiar with the domain of the discourse and encounter the word in different contexts (Landauer & Dumais, 1997). Hence, vocabulary development for these words occurs most effectively through a coherent course of study in which subject matters are

[8] Domain-specific words often found within a content area, e.g. *photosynthesis*

> integrated and coordinated across the curriculum and domains become familiar to the student over several days or weeks.[9]

This study sees the field of vocabulary learning as an innovative area for fostering the types of metacognitive and metalinguistic capabilities and awareness that are needed in preparing for and participating in the 21st century. The focus on vocabulary learning in the context of this study is particularly significant, as inquiry into word learning afforded opportunities for students to engage in problem solving, critical thinking, and theorizing about the multiple ways for learning how to learn or understand words, the types of capabilities, skills, and competencies found in the CCSS. Furthermore, this study illustrates just how important and productive vocabulary learning is as an area for innovative curricular design, student inquiry, and research on learning. In this study, students developed metacognitive and metalinguistic awareness as they reflected on aspects of their own language learning and word knowledge. These results suggest that a fruitful area for future work would be to examine how drawing on one's own *linguistic funds of knowledge* in developing word consciousness, including metacognitive and metalinguistic awareness of one's own word learning processes, has the potential to facilitate vocabulary learning and development. This generative approach to vocabulary learning prepares students to be expert learners in the twenty-first century and points to the richness of vocabulary itself is as a field for future research.

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[9] www.corestandards.org

Students in this study also came to understand that there are a multitude of strategies and approaches available to them in learning new words in a variety of contexts in their lives. They came to understand that they can use these strategies as they see fit, depending on their particular purposes and goals. By developing students' metacognition about word learning, word consciousness, and metalinguistic awareness, students may not only learn words as part of a specific task for school, but they could go on to learn more words independently by being more aware of when they encounter new words and how they are used, actively applying strategies for learning them when needed. This set of dispositions and capabilities is not only useful to students when encountering new words, they provide students with tools and strategies that can be drawn upon and applied strategically and flexibly in monitoring their own understanding and achieving their own learning goals. These are important ideas and capabilities that students may make use of and apply to their learning in any content area, in and outside of school. Ultimately, these learning experiences and ideas are important in developing students' knowledge and capabilities needed for becoming self-efficacious learners who take charge of their own learning in multiple domains of their lives.

In order to foster these types of learning and capabilities for the future for all students, and particularly for students from culturally and linguistically diverse backgrounds, students will need to have multiple experiences and opportunities for learning how to learn, thinking collectively about a problem, critically evaluating strategies for approaching them, and self-monitoring by stepping back to see if an approach is working. Moreover, in the future, whether in problem-solving, designing, or teaching in any field or domain, students will need to be equipped to collaborate—working, learning, and thinking together with others—in person, remotely, and virtually. This type of preparation will require similar types of collaborative learning opportunities in school, implemented across teachers, grade levels, and content areas, so that they may develop and transfer collaborative inquiry in their future work. These include higher order thinking skills and metacognitive awareness in flexibly using, managing, and critically evaluating strategies and approaches to learning and solving problems, manipulating them as tools for learning and meeting different goals. This study shows that curriculum engaging elementary students in collaborative inquiry into their own learning can foster these types of capabilities and awareness, and suggests the importance of developing such competencies as an important goal of schooling within and across disciplines and levels of study. It also shows the tremendous importance of providing English Learners and students from culturally and linguistically diverse backgrounds, such opportunities, in meeting the CCSS and preparing *all* students for success in college, career, and life by the time they graduate from high school.

Implications for Curriculum

A number of implications for curriculum development may be drawn from this study. First, this study serves as a model of curriculum and pedagogy in which a social constructivist and sociocognitive approach to teaching and learning using inquiry facilitates students' development of metacognitive capabilities as students develop deep conceptual understandings of science vocabulary, content, and academic language. The study also acts as a model of curriculum that establishes ways in which science content and scientific inquiry may be successfully integrated with the language arts. It illustrates the kinds of sophisticated inquiry research upper-elementary students are capable of, in which students act as scientists learning the process of scientific research by conducting inquiry into their own learning.

This study also argues for and provides a model of instruction which fosters students' development of metacognitive capabilities in the context of becoming self-efficacious, self-directed, expert learners. Such capabilities and learning are regarded as critical to public education, particularly given the information demands on citizens in the 21st century, which increasingly require students to have metacognitive capabilities, knowledge, and skills for learning. There is a growing need for people to be able to learn new things on their own, which necessitates that they be able to direct their own learning, often in the context of their work, in order to deal with complex issues and problems they encounter. This often involves acquiring and drawing upon different kinds of expertise, as well as capabilities for working with and listening to others (Bielaczyc & Collins, 1999; Murnane & Levy, 1996; U.S. Department of Labor, 1991).

The implications of this study for designing curricula that engage students in innovative approaches to learning vocabulary are also valuable. Rather than employing decontextualized and traditional models of vocabulary instruction, vocabulary learning in this study acted both as the content and vehicle for facilitating and enhancing students' development of metacognitive capabilities, theories, and the construction and application of conceptual models for learning vocabulary and academic language. The study also demonstrates that current trends in schools towards emphasizing content-area vocabulary and academic language needn't require that students be given discrete activities and word lists to memorize, as this work showed how students' emerging understanding of word knowledge and word consciousness expanded their conception of what it means to know a word. Conducting inquiry into their own processes for learning words in a content area in school provides students with an opportunity to learn academic language and vocabulary through engaging in a meaningful study of themselves as learners. Students in this study not only learned content-specific vocabulary in the study of ecology, they also learned scientific vocabulary relating to inquiry. In so doing, they came to see that there are different discourses or content-specific words relating to content and inquiry within an academic field.

Finally, this study presents a model of a curricular and pedagogical approach that is particularly important for culturally and linguistically diverse groups of students. By making students' language learning experience the object of their inquiry—drawing on their linguistic funds of knowledge—diversity in experiences, languages, and cultures is not only valued, it is central to everyone's learning, as each students' learning depends upon and benefits from such diversity. Conducting research into their theories of how they learn words, the implicit theories, prior knowledge, and real world experiences shared by students from culturally and linguistically diverse backgrounds, helped to inform and shape the big ideas at the center of the curriculum. As a result, students, with the scaffolding and support of the teacher, contemplated, developed, and even co-constructed ideas that are themselves central in the fields of metacognition, vocabulary development, and inquiry learning.

The findings herein indicate the value of engaging students from culturally and linguistically diverse backgrounds in a curriculum in which students engage in collaborative inquiry into their theories for learning new words. This is an especially important implication given that rich academic programming that goes beyond basic skills instruction has been found to be an important attribute of effective programs and classrooms serving ELs (August & Pease-Alvarez, 1996; Carter & Chatfield, 1986). Too often, curricula with the explicit aim of supporting ELs tend to focus on students' learning discrete skills and strategies, while executive processes and metacognitive knowledge receive the least amount of attention despite its important role in problem solving (August & Pease-Alvarez, 1996; Dillon, 1986). One longitudinal study of bilingual and structured English Immersion programs found that, regardless of the type of program, teachers tended to offer students a passive language learning environment and few opportunities to practice higher order thinking skills (Ramirez, 1992).

In the present study, we have found that ELs, while learning in a second language, not only can be successful, but flourish in an environment in which they are engaged in meaningful collaborative inquiry. This not only fosters a more complex and multifaceted understanding of vocabulary knowledge, it increases metacognitive capabilities and awareness for learning which are critical for learning and success in the 21st century. Giving ELs the opportunity to acquire an academic identity, one which includes drawing on and making use of their linguistic funds of knowledge through developing their metacognitive capabilities and awareness of that knowledge, is a viable and important alternative to current forms of curriculum.

In this curricular and pedagogical approach, the students were not being taught to do things in a particular way. They were given a template for learning which included trying out strategies for themselves, reflecting on their own learning process in light of particular learning goals, and theorizing about how and why they achieved the results they got. Students were encouraged to learn how to flexibly use multiple strategies, theories, and ideas for their *own* purposes. Such learning how to learn is a type of higher order thinking which, while not typical of traditional curriculum, can be used to understand a multitude of other areas and disciplines, including how people learn in other content areas and domains.

Implications for Teacher Practices and Education

Learning how to support teachers in developing curricular and pedagogical approaches that foster students' developing word consciousness and metacognitive capabilities, and to become self-efficacious learners of words, is important for understanding ways to meet the new CCSS and NextGen Science Standards, and for supporting students' future success in school, in their careers, and in their lives. This study underscores the importance and power of the role of teacher knowledge in such a pedagogical approach, and can serve as a resource for teachers learning to scaffold student learning. In this study, the background knowledge the teacher had of social constructivist learning theory, collaborative, scientific inquiry processes, and vocabulary development and learning processes was instrumental in her ability to scaffold collaborative theory development and student learning. That the teacher was able to draw upon multiple theoretical understandings and principles while scaffolding student learning has important implications for teacher education and professional development. In order to prepare teachers for such work, an understanding of the theoretical foundation of social constructivist theory is crucial, including how to scaffold learning while playing the role of a more expert other, and how to draw on one's knowledge of complex inquiry and reasoning processes in modeling and scaffolding while creating a cognitive apprenticeship within the classroom learning community.

The teacher was able to draw on theories of social constructivism and cognitive apprenticeship, along with ideas central to inquiry and vocabulary learning, while supporting students in collaboratively reasoning, reflecting, problem-solving, theorizing, and developing scientific arguments while coordinating theory with evidence. The apparent importance of teacher knowledge as a resource for scaffolding student learning speaks to the question of the best way to build pre-service and in-service teachers' knowledge of learning theory and processes.

One way for pre-service and in-service teachers to develop the types of skills and expertise exhibited in this study might be to engage in a collaborative inquiry project as part of their pre-service or in-service program. A key element would be the modeling, scaffolding, and support of a teacher mentor with expertise in inquiry, who could demonstrate how to make use of such knowledge and skills in practice, making these processes and practices explicit for the teachers. Within this context, the teachers, with their mentor, could collaboratively construct and apply a theoretical and analytical framework to help them understand and recognize the processes and practices at work. Having teachers participate in an investigation of how to teach using an approach that attempts to cultivate students' collaborative inquiry, would allow teachers to engage in a parallel meta-conversation and collaboration about ways to support students' learning. By sharing their students' experiences, work, and discourse, teachers can then construct, share, and reflect on strategies for scaffolding and engaging their own students in successfully participating in their collaborative inquiry learning process.

Such an approach is supported by a body of research showing the efficacy of engaging teachers in shared inquiry into their own practice (e.g. Palincsar et al., 1998; Scott et al., 2004; Frederiksen et al., 1998; 2015; Henry et al., 1999). For example, results from the *Vocabulary Innovations in Education* (Scott, Miller, & Flinspach, 2012; Miller, Gage-Serio, & Scott, 2010; Scott, 2015; Scott, Nagy, & Flinspach, 2008), a research project that investigated ways of fostering word consciousness in students by having researchers and classroom teachers collaborate to develop approaches for teaching culturally and linguistically diverse students, illustrates a model for professional development where such types of teacher learning can occur. Ensuring that such opportunities are a part of teacher education programs, and are available for practicing teachers' continued learning, affords opportunities for teachers to develop and acquire critical knowledge, and affords opportunities for the collaborative design and implementation of innovative curricular approaches, such as the model offered by this study.

Many school districts seek to create "professional learning communities" (PLCs) within schools, a cycle of inquiry into their own practices, driven by the use of formative assessment with the goal of improving practice to benefit students' learning (Astuto et al., 1993; Hord, 1997). The efficacy of such inquiry approaches to teacher professional development has been shown in work for the National Board for

Professional Teaching Standards, where teachers collaboratively reflected on their practice (Frederiksen et al., 1998). Engaging teachers in inquiry into their own practice as a group, trying out and sharing curricular and pedagogical approaches while supporting students to participate in inquiry into their own learning processes, could be a particularly strong vehicle for enacting the learning advocated by this study. While many school districts and teachers are familiar with a PLC framework for inquiring about and reflecting upon practice, this study indicates a need for closely examining the goals of investigations within a PLC model and mentoring to help both the teachers and the students engage in productive inquiry. There are many aspects of practice that can be investigated within a PLC model, and there are a variety of approaches implemented within PLCs, varying substantially among districts. Rather than focusing exclusively on specific content learning outcomes, such as in learning how to calculate products, this study suggests the importance and affordances of investigating ways to create student learning communities in which students participate in guiding their own learning, focusing on metacognitive aspects of how to learn and becoming more expert learners.

In this vision of PLC inquiry, the goal would be for students to develop collaborative inquiry and capabilities for students to become more expert learners within and across disciplines. The teachers will be engaged in their own action research, collaborating, and supporting one another through the inquiry processes, and reflecting on their own—and each others'—practice. This could look very different in different grade levels or disciplines, and teachers could choose to use one shared approach, co-constructing and implementing shared curriculum and reflecting on its' implementation and pedagogical practices, or teachers could choose to vary their approaches and share curriculum, learning outcomes, and pedagogical practices with one another. In this approach, there is no one "right" way, rather teachers would engage in reflective conversations about learning focused on higher-order goals for students and how to achieve them. Such an approach to professional development has the potential to critically impact teacher knowledge, practice, and student learning while helping to bring about the kind of change in teaching and learning needed for fostering the types of collaborative inquiry skills and metacognitive capabilities needed for the twenty-first century and which are found in the CCSS and NextGen Science Standards.

Implications for Assessment

Finally, this study has implications for the field of assessment. An important question in the field of the learning sciences, and advanced here, is how to possibly assess the types of skills and capabilities students will need in the twenty-first century. While students in this study demonstrated evidence of the development of sophisticated metacognitive capabilities while engaged in collaborative inquiry into their own theories of how they learn, evidence and demonstration of such capabilities are not likely to be captured easily in a large-scale summative standardized test. In fact, the Smarter Balanced Assessment Consortium (SBAC) assessments of the

Common Core State Standards now include "interim assessments," intended to "allow teachers to check student progress throughout the year, giving them actionable information to inform instruction and help students meet the challenge of college-and career-ready standards."[10] Despite this goal, the interim assessments (according to the Smarter Balanced Assessment Consortium website) are still administered as stand-alone tasks and are either based upon the "same blueprint as the summative assessments," assessing "the same range of standards," and providing scores on the same scale, or are administered as "Interim Assessment Blocks," which "focus on smaller sets of related concepts and provide more detailed information for instructional purposes."[11] One might reasonably question the feasibility and likelihood of being able to capture critical thinking, problem-solving, and collaborative inquiry processes, as well as the metacognitive capabilities entailed in their use, embodied in these standards, in stand-alone tasks disconnected from the learning and activity within the classroom community.

It is time for a paradigm shift in assessment, towards conducting assessment that is authentic, formative, and performance-based, occurring within the work of the learning community of the classroom. In this study, we have seen a considerable body of evidence of how students, by conducting inquiry into their own theories of how they learn, engaged in reflective assessment. A process of meaningful self-assessment

[10] http://www.smarterbalanced.org/interim-assessments/
[11] http://www.smarterbalanced.org/interim-assessments/

is built into the Web of Inquiry software by design (Frederiksen et al., 2015; White, Frederiksen & Collins, 2009; White & Frederiksen, 2005, White & Frederiksen, 1998), guiding students through the steps of the inquiry process, making the goals of each step of inquiry transparent to students as they consider them and assess their own progress towards meeting them. Self-assessment was also central in the students' inquiry in this study, as they conducted research on themselves as learners, co-constructing rubrics for reflecting on and assessing their own learning, and considering how their own data could be used transparently and convincingly as they disseminated results to others, including teachers.

Given that the future work of students will entail working with others, for instance problem solving in a group, it makes sense that students should be given opportunities to in such a context to learn in school. It also follows that after being given the opportunity to participate and learn in a collaborative context, students may then internalize processes involved in collaborative inquiry and problem solving. Collaborative assessments may be valuable and include evaluation of performance within circumstances where students are working in authentic situations with others, and then may be followed by teachers' evaluations of students, as teachers also help students to evaluate themselves. The larger question to focus on is a question of what knowledge to assess, beyond domain-specific knowledge. As Brown and Campione suggest in their work on Fostering Communities of Learners, this goes beyond a view of learning as the acquisition of "disciplined bodies of knowledge" and includes the development of students' higher-order skills, a cumulative knowledge base within a rich content area, a greater understanding of subject matter and technology, and students' "capability to learn and adapt to changing workplace demands" (Brown & Campione, 1996, p.289). It is possible to train teachers to gather and collect such data, and for the professional development of teachers to also provide a reliable source for assessing what students know and can do, both independently, and in their work with others.

Finally, the Word Learning Theories Assessment I designed and used for this study offers an innovative tool for assessing students' metacognitive thinking and epistemological beliefs. The assessment offers multiple sources of data, combining open-ended questions, Likert items in which students were asked to agree or disagree with decontextualized theory statements, and Likert items evaluating videos of student actors who were shown debating the merits of competing learning theories. Another unique feature of the assessment was that for all Likert item questions, students were asked to justify their choice in an open-ended response, providing qualitative explanations of their choices. Results of this study show that such an approach to assessment shows promise for investigating student's beliefs, and suggests that it would be valuable to verify this by testing the use of the assessment on a larger scale.

Limitations and Future Work

Although the results from this study provide important findings for theory-building and practice in response to two research questions, (1) "Does a collaborative learning environment in which students form and test their theories for learning new words in science facilitate the development of students' metacognitive capabilities?" and (2) "How does the instructional environment foster the development of these capabilities?" there are limitations to consider. An important limitation of this study to note is that it was conducted with the researcher serving as the teacher participant, examining her own practice. In addition to the potential biases inherent in such an approach, another limitation is that the curricular innovation took place with one teacher in her classroom over two years. While this provides a relatively small sample size, I attempted to address the limitations presented in conducting research within a single, intact classroom by carrying out the curriculum over two years in two different classes of students. In addition, I recruited two classes in the same grade and school to serve as comparison classes. Furthermore, I had strong background knowledge of the research literature, as well as experience teaching in ways that support students' development of inquiry knowledge and metacognition (see Frederiksen et al., 2015; White, Miller, & Borge, 2015), as well as of word consciousness (Scott, Miller & Flinspach, 2102; Miller, Gage-Serio & Scott, 2010). Further research is needed to investigate the extent to which these findings might be replicable by other teachers, with varying degrees of teacher knowledge and expertise in inquiry and word learning theory, and at other schools, with different demographics of students. For instance, while the participating classes at Ocean Side were culturally and linguistically diverse, it would be interesting to see if the same patterns of results would be found at schools with more linguistically homogeneous student bodies, including those predominantly serving students learning in a second language and those serving students who are predominantly fluent in English (the most dominant language used in U.S. schools). Such a comparison might help to illuminate what impact a culturally and linguistically diverse student body has on a curriculum that places students' cultural and linguistic funds of knowledge at the center of learning and inquiry.

Another area for further exploration is how this curricular approach impacts students' development of vocabulary. As part of the curriculum, the students co-constructed the rubric used for evaluating their own word knowledge on the Word Knowledge Rating Guide self-assessment. The same rubric was used to score students' word knowledge for the Vocabulary Word and Science Content Assessments. After the students' word assessments were scored, the students used the results from both the word assessment and the self-assessment to analyze the class' developing knowledge of scientific vocabulary with respect to various learning theories and their accompanying strategies. They did so by comparing mean scores for each learning strategy, as well as by identifying and comparing patterns in the pretest and posttest scores for both the Vocabulary Word, Science Content Assessments, and the Word Knowledge Rating Guide self assessment (see Figure 6 for example graphs). The results of these assessments showed that students did in fact develop scientific vocabulary while participating in the curriculum, and pointed to which strategies students found to be most effective for learning differing types or aspects of word knowledge. Further analyses of these assessments is necessary to develop a more detailed understanding of the impact the curriculum had on students' knowledge of scientific vocabulary. This could include understanding more about how students' vocabulary knowledge grew and changed with respect to the different learning approaches they used. It could also include how students' word consciousness influenced their vocabulary learning over time, as well as document the context and demonstrations of this growth..

Anecdotal observations noted by the researcher while implementing the curriculum and collecting data included that some students, without prompting, used the language from for levels of performance ratings in the Word Knowledge Rating Guide self-assessment in answering questions on the Vocabulary Word and Science Content Assessments. This suggests that some students may have internalized and transferred the metacognitive continuum represented in the rating guides and applied the conceptions of word knowledge embodied in the rating guides to other word-related tasks and contexts. Another observation was that, after engaging in group learning using a situated and experiential approach to word learning with a more expert-other, some students in their Vocabulary Word and Science Content posttests (in which students were encouraged to draw and label everything they knew about the meaning of a word), were more likely to offer, draw, or label examples of the word and things related to it that they saw for themselves or experienced first-hand. Furthermore, some students, after using this approach, seemed more likely to represent a polysemous word on the Vocabulary Word and Science Content posttest as it is used in science, giving it's scientific meaning rather than offering a more common, everyday meaning. For example, even though students were asked in the assessment to "think of a situation involving the word as it is used in science," many students tended to represent the particular meaning, situation, or context of the word that was more familiar to them, such as drawing the school and labeling it to represent the word "community" rather than representing an ecological community. Students who had just engaged in the situated and experiential learning strategy more often represent the word as it is used in science than students who had just used the reading or flashcard strategies. Such anecdotal observations beckon a more systematic analysis of these data sources for understanding the impact the curriculum had on students' vocabulary knowledge and learning.

Another area for further exploration includes understanding the impact that engaging students in an inquiry into their own theories for how they learn had on students' knowledge of scientific inquiry. In addition to the Vocabulary Word and Science Content Assessments and Word Knowledge Rating Guides, students' Inquiry pretests and posttests are available for further analysis as well. This analysis could help to show how the curriculum contributed to students' understanding of and competencies in performing inquiry, and show whether there were any differential impacts on sub-groups of students, including those who are designated as ELs. Students' inquiry project reports and video of whole class and small group work could be analyzed for evidence of how students understood and put the ideas of inquiry to use as they engaged in the inquiry process.

Finally, future work suggested by this research includes expanding these studies to investigate additional academic content areas, and exploring students' theories of word learning which transcend the boundaries of learning in school, investigating and conceptualizing language learning as the fluid and situated movement between and among all domains in students' lives. Future research could investigate home contexts, cultures, languages, identities, and the role family members and other mentors play in language learning and vocabulary development. An important contribution of such work would be to investigate and characterize bilingual students' and ELs' theories, experiences, and learning through inquiry into their theories of learning language across cultural and linguistic domains in their lives. By engaging students in multiple iterations of inquiry into their own theories of language learning, expanding their inquiry to include domains beyond classroom walls, students will develop a more wide-ranging and complex understanding of inquiry. This would include developing and employing diverse research designs and methodologies, including processes for collecting and analyzing multiple data sources, in order to develop a more nuanced, situated, and complex understanding of how students learn new words.

Conclusion

Information demands on citizens in the 21st century increasingly require students to have metacognitive capabilities, knowledge, and skills for learning, problem solving, and conducting collaborative inquiry. As Bielaczyc and Collins (1999) emphasize, there is a growing need for people to be able to learn new things, both in groups, and on their own, which requires that they be able to direct their own learning, often in the context of their work, in order to deal with complex issues and problems they encounter. Meanwhile, the U.S. Department of Labor's SCANS report (1991), as well as Murnane and Levy (1996), elaborated the skills and knowledge needed for work in the 21st century, and both include being able to direct one's own learning, working with and listening to others, and developing ways of dealing with complex issues and problems that require different kinds of expertise. Among these, learning how to acquire new concepts and vocabulary are also increasingly important in preparing students to participate in the workforce of the 21st century as professions develop and rely on more specialized technical vocabulary used in communication (Askov & Gordon, 1999). Moreover, vocabulary knowledge itself is critical to students' literacy development, reading comprehension, and academic success in schools (NICHD, 2000; RAND Reading Study Group, 2002), especially beginning in upper-elementary grades when instructional goals shift to require students to read texts containing unfamiliar, domain-specific vocabulary (Lapp, Flood, & Ranck-Buhr, 1995), and to demonstrate proficiency in multiple subject areas such as science (Armbruster & Nagy, 1992; Bravo, Hiebert & Pearson, 2005; Gee, 2008; Snow, 2008). With increasing cultural and linguistic diversity in schools and the workplace, vocabulary learning becomes an equity issue as well, and is especially crucial for ensuring access to curriculum and information for those who are learning in a second language.

Given these goals for teaching, learning, and preparing students for their futures in the 21st century, this study indicates the powerful impact engaging students has in an inquiry into their own learning. The results from this study show that students have become more aware of the multiple ways people learn new words, they can use multiple strategies for learning them (both individually and collectively), and they are more aware of the variety of purposes for learning them. Students, while engaged in collaborative inquiry, developed metacognitive capabilities while coordinating theory with evidence from their investigation, a challenging and sophisticated aspect of inquiry learning that is emphasized in the new Common Core State Standards and NextGen Science Standards. Furthermore, there are implications in the underlying theoretical and pedagogical principles of this work for preparing teachers to undertake such an approach with their students. These include the affordances of teachers participating in a teacher community of learners with a more knowledgeable mentor, collaborating and reflecting on teaching practices fostering such an approach, while simultaneously engaging students in collaborative inquiry learning into their own theories. Finally, this study supports a call for a paradigm shift away from vocabulary assessment focusing on *what words or aspects of word knowledge students know,* moving towards including *how they know to find or posit meanings for words they encounter and need*. This vision for assessment would entail understanding ways students may act as an expert in the process of understanding new words, including new ideas, forms of a word, or other word schematic knowledge. This type of knowledge is arguably as important—if not more so—than simply assessing the vocabulary knowledge students have already acquired. Efforts in this direction have shown promising results (Scott et al, 2008; Miller, Flinspach & Scott, 2010).

Taken together, these findings show how inquiry, metacognition, and vocabulary learning may be developed through *collaborative inquiry into one's own learning as a pedagogical approach*. By demonstrating just what fourth-graders are capable of in this regard, this study has important implications for curriculum development, teaching practices, teacher education, and assessment, particularly for the upper-elementary grades. This study advances a new vision for teaching and learning, in which students, by conducting inquiry into their own theories, act as agents of change in their own learning, and develop capabilities as self-efficacious, metacognitive, and reflective learners in the process.

APPENDIX A

Fourth Grade Content Standards for California Public Schools

Life Sciences

2. All organisms need energy and matter to live and grow. As a basis for understanding this concept:
    a. Students know plants are the primary source of matter and energy entering most food chains.
    b. Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.
    c. Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.
3. Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:
    a. Students know ecosystems can be characterized by their living and nonliving components.
    b. Students know that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.
    c. Students know many plants depend on animals for pollination and seed dispersal, and animals depend on plants for food and shelter.
    d. Students know that most microorganisms do not cause disease and that many are beneficial.

Investigation and Experimentation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
    a. Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.
    b. Formulate and justify predictions based on cause-and-effect relationships.
    c. Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.
    d. Construct and interpret graphs from measurements.

e. Follow a set of written instructions for a scientific investigation.

Reading

1.0 Word Analysis, Fluency, and Systematic Vocabulary Development

Students understand the basic features of reading. They select letter patterns and know how to translate them into spoken language by using phonics, syllabication, and word parts. They apply this knowledge to achieve fluent oral and silent reading.

1.1 Word Recognition
Read narrative and expository text aloud with grade-appropriate fluency and accuracy and with appropriate pacing, intonation, and expression.

1.2 Vocabulary and Concept Development
Apply knowledge of word origins, derivations, synonyms, antonyms, and idioms to determine the meaning of words and phrases.

1.3 Use knowledge of root words to determine the meaning of unknown words within a passage.

1.4 Know common roots and affixes derived from Greek and Latin and use this knowledge to analyze the meaning of complex words (e.g., international).

1.5 Use a thesaurus to determine related words and concepts.

1.6 Distinguish and interpret words with multiple meanings.

APPENDIX B

Word Culling: Selecting Core Vocabulary Words for the Curriculum

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Initial Word Culling by Themes Using FOSS Text for Grade Four *Science Resources* and *California Science* for grade four by Harcourt Brace

FOSS *Science Resources*
Theme: Ecosystems
Pages: 120-122
38 Words Culled in 3 and pages (includes some graphics and photographs)

Ecosystem	Factors	Measure	Metal	Carbon dioxide
Community	Aquarium	Environmental	Machines	Sunlight
Organisms	Water plants	Temperature	Grow	Light
Nonliving	Woods	Water	Move	Converted
Environment	Natural	Light	Sense	Chemical energy
Terrarium	Insects	Interact	Reproduce	Photosynthesis
Soil	Interacting	Matter	Captured	
Main	Ecologists	Energy	Leaves	

Harcourt Brace *California Science*
Theme: Ecosystems
Pages: Vocabulary – p.209, text p. 212-9, questions p. 220
71 words culled in 8 pages (many graphics and photographs)

Ecosystem	Forest	Burros	Provide	Flooding	Determine
Living	Meadow	Bighorn sheep	Shelter	Rich (soil)	Cacti
Nonliving	Red-winged blackbirds	Adapted	Parts	Poor soil	Insects
Organisms	Wetlands	Survive	Climate	Harmful	Hand lens
Soil	Willow flycatcher	Tidal pool	Rainfall	Substance	Pockets (of air)
Individual	Willow trees	Tide	Receives	Chemicals	Dampness
Population	Nest (verb)	Taiga	Pattern	Burns (gasoline)	Northern
Form	Community	Make up	Air temperature	Harm	Southern
Members	Forming	Depend	Biome	Produce	Ecology
Garter snake	Desert community	Spread	Affect	Roots	Ecologists
Gopher snake	Death Valley National Park	Seeds	Wilt	Absorb	Suppose
Increased	Adjust	Coniferous Forest	Moose	Amount	

FOSS *Science Resources*
Theme: Food Chains and Food Webs
Pages: 123 – 127
56 Words Culled in 4 pages

Survive	Roots	Decompose	Woodland	Bass
Source	Herbivores	Break down	Jay	Minnow
Raw materials	Carnivores	Fungi	Praying mantis	Mayfly
Grow	Robins	Bacteria	Weasel	Compete
Producers	Crayfish	Chemicals	Describe	Competitions
Terrestrial	Omnivores	Nutrients	Direction	Ecosystem
Bushes	Scavengers	Returned	Energy flow	Depend
Fresh water	Vultures	Food value	Chipmunk	Waste
Algae	Isopods	Simple chemicals	Seed	
Consumer	Termites	Recyclers	Organisms	
Plant parts	Decomposers	Food chains	Food webs	
Gophers	Microorganis ms	Feeding relationship	Egret	

Harcourt Brace *California Science*
Theme: Food Chains and Food Webs
Pages: Vocabulary – p.181, text p. 184-7, questions p. 188
38 words culled in 3 pages

Depend	Predator	Compete	Nutrients	Land
Food chain	Prey	Limit	Break down	Herons
Movement	Cougars	Energy	Plant matter	Plankton
Energy	Grasslands	Transferred	Waste	First-level consumers
Sequence	Antelope	Level	Food source	Second-level consumers
Order	Increasing	Cycled	Overlap	Top-level consumers
Producers	Population	Organism	Food web	
Consumers	Starve	Decomposers	Habitats	

FOSS *Science Resources*
Theme: Interdependence
Pages:107-110
37 words culled in 4 pages

Depend	Depend	Insects	Scatters	Twigs
Survival	Stems	Moths	Dispersing	Pollen
Shelter	Sap	Seed Dispersal	Hooks	Disperses
Branches	Roots	Seeds	Pollinate	Walkingsticks
Protected	Bark	Ripe	Term	Nectar
Predators	Swollen thorn acacia tree	Sprout	Honeybees	Describe
Beetles	Protection	Parent plant		Cactus
Isopds	Pollination	Nutrients		

Harcourt Brace *California Science*
Theme: Interdependence
Pages: Vocabulary – p. 241, text p. 244- 249, questions p.250
37 words culled in 4 pages

Depend	Herds	Hosts	Pollen	Grow
Trust	Protection	Red-breasted geese	Female part	Herbivores
Rely	Prides	Arctic	Pistil	Carnivores
Support	Compete	Nests	Pollinate	Omnivores
Interdependence	Connection	Peregrine falcons	Seeds	Spread
Reliance	Relationship	Defend	Form	Fruit bats
Dependence	Cleaner shrimp	Protect	Insects	Crops
Mutual dependence	Parasites	Warn	Nectar	Coats (dogs)
Mutually dependent	Harmful	Pollinating	Pollinator	Droppings
Survive	Organisms	Male parts	Pollinated	Nests
Living things	Feed	Produce	Form	Dens
Prevents	Leopards	Lumber	Fuel	Electricity
Medicines	Weaverbirds	Materials	Unusual	Briars
Sprout	Bury	Spreading	Crowding	Space
Thorns	Shelter	Predators	Protect	Canopies
Rain Forests	Steel			

Word Culling: Selecting Final Unit Core Vocabulary

Key:

a) New concept, 'core' vocabulary
b) Different use of a familiar word
c) Attaching a new label to a known concept

Ecosystems:

1. Ecosystem – a
2. Community – a, b
3. Interacting – c
4. Energy – b
5. Ecology – a
6. Climate – a

7. Matter – b
8. Population – a
9. Reproduce – a
10. Adapted (adaptation) – a
11. Rich (soil) – b
12. Affect – c
13. Produce (verb) b, c
14. Increase – b
15. Adjust – c
16. Absorb – c
17. Grow – c
18. Capture (sunlight) – b, c
19. Convert (into) – c

6 Core Words: Ecosystem, community, adaptation, Population, Ecology, Reproduce
6 Other Words: Interacting, Energy, Matter, Increase, Convert, Produce

Food Chains:
1. Raw materials – a, b
2. Producers – b
3. Consumers – b
4. Decompose – a
5. Herbivores – a
6. Carnivores – a
7. Omnivores – a
8. Scavengers – b
9. Predator – a
10. Prey – b
11. Cycle (verb)/recyclers – b
12. Algae – c
13. Terrestrial – a
14. Microorganisms – a
15. Fungi – c
16. Bacteria – c
17. Food chain – a
18. Food web – a
19. Waste (noun) – b
20. Limit – b
21. Transferred – b
22. Habitat – a, b
23. Energy – b

24. Compete – b

6 Core Words: Decompose, herbivore, carnivore, omnivore, predator, food chain
6 Other Words: Consumers, producers, prey, scavenger, raw materials, habitat

Interdependence:

1. Interdependence – a
2. Shelter – b
3. Survival – b
4. Protected – b
5. Pollinate – a
6. Seed dispersal – a
7. Depend – b
8. Competition – b
9. Nectar – c
10. Canopies – c
11. Pollen – c
12. Parasites – a
13. Crowding – b
14. Fuel – a
15. Rely – a
16. Harmful – b
17. Droppings – c
18. Space – b
19. Predator— a
20. Relationship – b
21. Spreading – b
22. Materials – b

6 Core Words: Interdependence, pollinate, parasite, seed dispersal, fuel, rely
6 Other Words: Shelter, survival, protected, depend, competition, relationship

APPENDIX C

Word Learning Theories Assessment

Word Learning Theories Questionnaire

We want to find out your theories about how people learn new words. There are no right answers to this questionnaire, so just do your best. Your answers will be very important in studying the effectiveness of the word learning inquiry curriculum. There are 3 different parts to this questionnaire.

Sample A:
Questions on Part 2 will be like this example

DIRECTIONS: For each of the following questions, please read the statement and circle the option that describes how strongly you agree or disagree. Also, write a couple of sentences explaining why you answered the way you did.

Reading is something you need to be able to do for school and for work, but it isn't as important or necessary for life outside of school or work.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

Sample B: Questions on Part 3 will be like this example

DIRECTIONS: In each of the questions, you will see a video of a short discussion between two students who disagree about some issue. Then you will *circle the letter* of the statement to show whether you agree with one student, the other student, or both. Finally, you will write a couple of sentences explaining why you answered the way you did.

Cynthia: I heard that the school district is thinking about making the school day longer. I like that idea because we would learn more. That can help us to do better in middle school and high school, and then get into college, and that could help us get a good job one day.

Lettie: I disagree. I get tired in the afternoon and I don't think I learn as much when I'm tired. I think maybe we reach a point in the day when we've learned as much as we can, and even if we did spend more time in school we wouldn't learn more. It could be a waste of time.

(a) I agree almost entirely with Cynthia.

(b) I agree more with Cynthia, but I think Lettie makes some good points.

(c) I agree (or disagree) equally with Cynthia and Lettie.

(d) I agree more with Lettie, but I think Cynthia makes some good points.

(e) I agree almost entirely with Lettie.

Why?

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____

____

____

Part 1 (Questions 1 – 4)

1. Why do people learn new words? List as many different reasons as you can:

2. When do people need to learn new words? Think of times and events when learning new words might be important. List as many as you can.

3. How do people learn new words? List as many ways to learn new words as you can:

4. What does it mean to know a word? List some ways to show that you know a word:

Part 2 (Questions 5–15)

DIRECTIONS: For each of the following questions, please read the statement and circle the option that describes how strongly you agree or disagree. Also, write a couple of sentences explaining why you answered the way you did.

5. Knowing a word is the same as knowing its definition.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

6. The best way to learn a word is to find out the definition from the dictionary and then study it.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

7. When you are given a chance to choose how to learn new words, you should always think about what type of words they are and what it means to know them.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

8. You can't really figure out the meaning of a word you don't know from the rest of the sentence.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

9. It's possible to know a word without knowing what it means.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

10. You can't really use a word if you don't know how to define it.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

11. Choosing which way to learn new words depends on what you need to know them for (a quiz, writing a story, or a science project, etc.).

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

12. You can learn and understand a word well without hearing it or seeing it used.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

13. Learning new words is mostly something you do in school rather than outside of school.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

14. It's better to learn new words when someone uses them to explain how to do something, like how to do a magic trick.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

____

____

____

15. You learn new words better by studying them by yourself rather than by hearing them being used as part of a group.

(a) strongly agree
(b) somewhat agree
(c) somewhat disagree
(d) strongly disagree

Why?

Part 3 (Questions 16-24)

DIRECTIONS: In each of the questions, you will see a video of a short discussion between two students who disagree about some issue. Then you will *circle the letter* of the statement to show whether you agree with one student, the other student, or both. Finally, you will write a couple of sentences explaining why you answered the way you did.

16. Leticia: Did you do the science reading yet? Jose said there were a bunch of words he didn't understand, and when he tried answering the review questions he had a hard time.

Dawn: Well, did he look them up in the dictionary? I mean, that is the best way to figure out words you don't know. You can have a dictionary right there, and look up the words you don't know as you read. Then you don't have to worry about guessing and it's wrong.

Leticia: I don't agree that's the best way. What I do is I first try to use the rest of the sentence to help me figure it out, and I also think of things related to the word that come into my mind, even if I can't give an exact definition.

(a) I agree almost entirely with Leticia.
(b) I agree more with Leticia, but I think Dawn makes some good points.
(c) I agree (or disagree) equally with Leticia and Dawn.
(d) I agree more with Dawn, but I think Leticia makes some good points.
(e) I agree almost entirely with Dawn.

Why?

____

____

____

What would you do?____

____

17. Hector: I don't think there is one best way to always learn new words. It depends on the word. Maybe there are some words that don't have a simple definition, that are harder to understand. You may need to spend more time on those words, maybe working with someone who really understands them, or by getting a chance to experience what the words means for yourself.

Jamal: I'm not so sure about that. It seems to me that if you are trying to learn new words there are some definite ways to learn them no matter what the words are. After all, a word is a word, isn't it? I don't see why it would matter what kind of word it is. You just need to find out what it means, like by looking it up or asking someone, then you study it by practicing or looking at it and trying to remember what it means.

(a) I agree almost entirely with Hector.
(b) I agree more with Hector, but I think Jamal makes some good points.
(c) I agree (or disagree) equally with Hector and Jamal.
(d) I agree more with Jamal, but I think Hector makes some good points.
(e) I agree almost entirely with Jamal.

Why?

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____

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____

____

18. Luis and Victor were given a list of science words to learn for a test at the end of the week and their teacher said they can work together to study however they want. They are discussing what to do to learn the science words for their test.

Luis: I think we should make flash cards and study them. We can look up the words in the dictionary, and then write the science word on one side and the meaning on the other. We don't need to work together if we don't want to. Then we just need to study them before the test.

Victor: I think it depends on how well we want to understand the words. If we study a definition, is that really learning what it means? Maybe we should do a group project or something, and try to see how the words are used in action.

(a) I agree almost entirely with Luis.
(b) I agree more with Luis, but I think Victor makes some good points.
(c) I agree (or disagree) equally with Luis and Victor.
(d) I agree more with Victor, but I think Luis makes some good points.
(e) I agree almost entirely with Victor.

Why?

____

____

____

What would you suggest if you were in Luis or Victor position?

____

____

19. Alison and Alicia decided to ask their teacher more about the test to help them decide on which way to study. The teacher said that she wanted them to really understand the ideas each word represented. They are debating which approach to use to learn the science words for their test.

Alison The teacher said she wants us to really understand the words. I'm not sure that learning a definition will do it. What if the test questions don't ask for a definition? I think we need to really investigate what these words mean, and that will help us to answer any questions.

Alicia: Hang on, I think looking the words up and making flashcards will help us to know the real definition and meaning of the words so we get it right for the test. After all, if it comes from the dictionary, it's got to be right. Then we just need to study them before the test.

(a) I agree almost entirely with Alison.
(b) I agree more with Alison, but I think Alicia makes some good points.
(c) I agree (or disagree) equally with Alison and Alicia.
(d) I agree more with Alicia, but I think Alison makes some good points.
(e) I agree almost entirely with Alicia.

Why?

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____

____

What would you suggest if you were in Alison or Alicia's position?

____

____

20. Sara: I think there might be different ways to learn new words depending on what the words are and what you are learning them for. When I'm reading and there's a word I don't know, I might try and look for clues in the sentence or think about the topic, but when I'm learning how to do something, like cooking, I might learn words by listening to my parents and watching what they do and how they use the words.

Lily: I don't think how we learn new words depends much on the situation. Why would it matter what the reason is for learning a word? You still have to learn what it means to know it and to use it, no matter whether it is for school or for something else, like if you are reading something. If you don't know a word, you just need to find out what it means, either by looking it up or by asking someone.

(a) I agree almost entirely with Sara

(b) I agree more with Sara, but I think Lily makes some good points.

(c) I agree (or disagree) equally with Sara and Lily.

(d) I agree more with Lily, but I think Sara makes some good points.

(e) I agree almost entirely with Lily.

Why?

21. Jackson and Sammy are doing a project in school about learning new words and are discussing their topic.

Jackson: I really think that we learn new words when we're in school. I mean, I don't necessarily learn a lot of words outside of school, except maybe for homework when I'm studying for a vocabulary test or when I have to look up and write down definitions of words or something.

Sammy: I think I learn new words in school and out of school, like at home listening to my parents talking and using words I don't know, or when I'm reading or watching T.V. and there's a word I see or hear that I'm not sure about, and I'll ask them what it means.

(a) I agree almost entirely with Jackson.

(b) I agree more with Jackson, but I think Sammy makes some good points.

(c) I agree (or disagree) equally with Jackson and Sammy.

(d) I agree more with Sammy, but I think Jackson makes some good points.

(e) I agree almost entirely with Sammy.

Why?

22. Jennifer and Stephanie sit at the same table group. Their teacher has given them class time to learn some new words. They can work together or separately, and are discussing which they should do.

Jennifer: I think it's better to learn things together. It really helps me to talk about ideas with someone else, to see if someone else understands things the way I do. Like with these new words, maybe someone else knows more about them, or has seen or used them before, and can describe them. Or I can help someone else. You can only do that by working in a group.

Stephanie: I think I learn better if I'm working by myself. If I don't know a word, I can just look it up, I don't need to hear about it from someone else, that isn't necessarily better than using the dictionary. Also, if I work alone, I can focus more on learning the words I don't know yet and skip the words I already know. After all, working in groups can waste time.

(a) I agree almost entirely with Jennifer.

(b) I agree more with Jennifer, but I think Stephanie makes some good points.

(c) I agree (or disagree) equally with Jennifer and Stephanie.

(d) I agree more with Stephanie, but I think Jennifer makes some good points.

(e) I agree almost entirely with Stephanie.

Why?

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____

____

____

23. Rickie and Marcio are thinking about how they learned as part of a science unit they are finishing in class.

Rickie: Have you noticed that a lot of the science words we didn't know before we now use when we talk to each other in class? I think using the words as a class helps us to figure them out and learn them together.

Marcio: Yeah, we are all using a lot of new words, but maybe that's because we read about them or learned them on our own. I'm not convinced that talking about them and using them as a class made any more difference than just learning them by ourselves.

(a) I agree almost entirely with Rickie.
(b) I agree more with Rickie, but I think Marcio makes some good points.
(c) I agree (or disagree) equally with Rickie and Marico.
(d) I agree more with Marcio, but I think Rickie makes some good points.
(e) I agree almost entirely with Marcio.

Why?

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____

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____

24. Chrissy and Angelica are discussing what it means to know a word**:**

Chrissy: I think knowing a word is the same as knowing what it means. Think about it, in school aren't we told a lot by teachers to "go look it up" when we don't know a word? Or if we are taking a test or answering questions, they ask us to give a definition to show that we know the word.

Angelica: I think knowing a word is more than knowing what it means. I can think of words that I've learned the definition of but I couldn't really use them in a sentence. I think knowing a word is knowing what it means and being able to use it and understand what it's related to.

(a) I agree almost entirely with Chrissy.

(b) I agree more with Chrissy, but I think Angelica makes some good points.

(c) I agree (or disagree) equally with Chrissy and Angelica.

(d) I agree more with Angelica, but I think Chrissy makes some good points.

(e) I agree almost entirely with Angelica.

Why?

APPENDIX D
Sample Web of Inquiry Project

Project Report

Anemones Project
Anemones
Jenny , Athena , Emma
9/9/09

Questioning and Theorizing

how do people learn new words you can learn new words by... >going on a field trip because... you can expeiriance it >making flash cards because... >taking a quiz/test because...

Our Research Topic

how do people learn new words you can learn new words by... >going on a field trip because... >making flash cards because... >taking a quiz/test because...

Variables

Variables-we will change the way we try to learn new scientific words -we are trying to change/learn new words -We will keep the same how time we spend, what time of day we do it, how many words we try to learn how hard the words are -we will measure this by tests about the words.

Our Theories

one of our theories is that by using flash cards it can improve your reading, spelling and understanding them because when you look at the word like "cough" you'll see that the f sound is actully gh and if you write the definition on the back of the flashcard then you can ask somebody else in your family to read the word then you say the definition and spell it.

Another one of our theories is that if you go on a field trip you will experience or see the word in action. it is fun because you can see it in action and the expert could tell you what the definition of the word is if you asked for it.

Another theory is if you read another part of the sentence will tell you what the word means, and sometimes there's little captions and examples of how to use the word, and books can also give you the defini tion or you can look in the glossary.anoth

Possible Questions

Does spending more time on the feildtrip effect your research?

Does looking at a dictionary help more than studying flashcards or going on a feildtrip?

Does reading help you understand the words better than other strategies?

Is one of these stratigies better than another?

Our Specific Question

Does reading help you understand the words better than other strategies? This will help us learn how people learn new words best.

Forming Hypotheses

.

Our First Hypothesis

Yes, reading will work better than the others because seeing the words and pictures will help you memorize the words.

Our Second Hypothesis

Maybe reading will work just as well as the others because it is basicly the same as the others but it only makes a diference if you spend more time on one than the others. It is the same as the others because each way you still learn the words, but it also helps you learn them better by seeing the word and picture.

Our Third Hypothesis

No, reading will not work better than the others because some would be funnest but, you will learn the same thing.

Investigating Our Hypotheses

Hypothesis 1:Yes, reading will work better than the others because seeing the words and pictures will help you memorize the words.

Hypothesis 2:Maybe reading will work just as well as the others because it is basicly the same as the others but it only makes a diference if you spend more time on one than the others. It is the same as the others because each way you still learn the words, but it also helps you learn them better by seeing the word and picture.

Hypothesis 3:No, reading will not work better than the others because some would be funnest but, you will learn the same thing.

Variables

variables we will change... how we learn new words, flashcards, field trip , and reading variables we will keep the same... amount of time spent number of words effort we put in time of day how hard the words are variables we can measure... a check list of words we know no i dont no the word never heard them or seen them sort of know the word ... seen it heard it dont know meaning or how to use it know part of the word

Detailed Plan

1.choose 30 words -get three lists of ten scientific words

2.take a pretest on the ten words use up 15 minutes

3.spend 30 minutes making flashcards, using the dictionary to look up words and test eachother

4. do a post test use up 15 minutes, please make sure it is quiet and dont rush

\]

Test Our Hypotheses

Hypothesis 1:Yes, reading will work better than the others because seeing the words and pictures will help you memorize the words.

If this hypothesis was accurate, we would find that the difference from pretest scores to posttest scores were higher than the other strategies' postest scores. This means there was more growth in your knowledge using the strategy of reading.

Hypothesis 2:Maybe reading will work just as well as the others because it is basicly the same as the others but it only makes a diference if you spend more time on one than the others. It is the same as the others because each way you still learn the words, but it also helps you learn them better by seeing the word and picture.

if this hypothesis was accurate we would find if it is basicily the same as the other strategies or if it doesn't work as well as the others. we will also learn if it is better to see the pictures and read the captions and if it will help you grow your knowledge of learning words.

Hypothesis 3:No, reading because some would be funnest but, you will learn the same thing.

if this hypothesis was accurate we would find that

Our Data

class average for word assessment : field trip - .98 flash cards- .63 reading- .27

class averages for self assessment : field trip- 1.10 flash cards- .92 reading- .65

Comparing Word Self Assessment Averages for all Strategies

	Change_in_Scores	No_of_Students_FC	No_of_Students_Read	No_of_Students_FT
1	-.99 to -0.50	0.0	0.0	0.0
2	-0.49 to 0.00	0.0	6.0	0.0
3	.01 to .50	8.0	8.0	4.0
4	.51 to 1.00	6.0	4.0	8.0
5	1.01 to 1.50	6.0	2.0	8.0
6	1.51 to 2.00	2.0	0.0	1.0
7	2.01 to 2.50	1.0	0.0	1.0
8	2.51 to 3.00	0.0	2.0	1.0
9	3.01 to 3.50	0.0	0.0	0.0

Comparing Word Assessment Averages for all Strategies

	Change_in_word_Score	No_stud_FC_Content	No_stud_Read_Content	No_stud_FT_Content
1	-1.49 to -1.00	0.0	1.0	0.0
2	-.99 to -0.50	0.0	0.0	0.0
3	-.49 to 0.00	3.0	7.0	0.0
4	.01 to .50	7.0	6.0	4.0
5	.51 to 1.00	9.0	9.0	10.0
6	1.01 to 1.50	3.0	0.0	6.0
7	1.51 to 2.00	1.0	0.0	3.0
8	2.01 to 2.50	0.0	0.0	0.0
9	2.51 to 3.00	0.0	0.0	0.0
10	3.01 to 3.50	0.0	0.0	0.0

Problems

>some people left blank spots in the pretest and post test (missing data) >some people didn't get to practice with their flashcards or forgot to make a flashcard >reading was hard if their were other words in the definition that they didn't know >some people were absent so we did make-ups later , timing slightly off, not working as a group >4 of the students were not taking the post test right away after the field trip >some people didn't have enough time for the post test

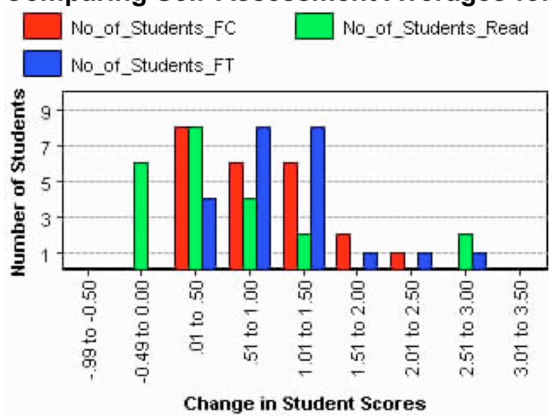
Analyzing Our Data

.

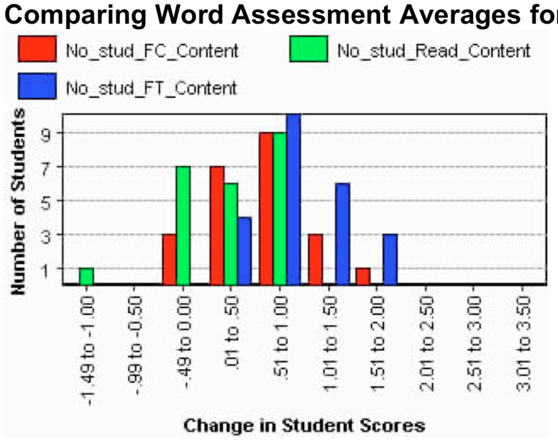
Data Summaries

we were comparing startegies for learning new words. As we tested the three strategies (reading, making flashcards, and going on a field trip) field trip turned out the most helpful. Then we took our data and used it to make a list of strategies for teachers to teach students new words.

Comparing Self-Assessment Averages for All Strategies



Comparing Word Assessment Averages for All Strategies



Patterns In Our Data

>highest growth was for field trip and flashcardds >people didnt make any growth from reading >only two people for reading, one person for field trip made highest growth >for flash cards and field trip, all students made growth >16 students almost 2/3 of the class made made 1-1/2 columns growth >more students overall made less growth with reading and flash cards >students made more than a 1/2

a columns growth with field trip while 15 for flash cards >more students made more growth with field trip >more people (3)made more than 1 1/2 columns growth with field trip >more people (3) made more than 1 1/2 columns growth with field trip, only (1) made 1 1/2 or more growth with flash cards

Findings

Hypothesis 1:Yes, reading will work better than the others because seeing the words and pictures will help you memorize the words.

Hypothesis 2:Maybe reading will work just as well as the others because it is basicly the same as the others but it only makes a diference if you spend more time on one than the others. It is the same as the others because each way you still learn the words, but it also helps you learn them better by seeing the word and picture.

Hypothesis 3:No, reading will not work better than the others because some would be funnest but, you will learn the same thing.

reading got the lowest average for our class. so really,we were wrong! we thought that reading would work best because we could actully see the sentence and remember in our minds. throughout the project we have found out that reading did not work. we found this by observing our graph. it was interesting to see our results because we thought differently.

Synthesizing

Our Current Best Theory

We think that when you're learning words in science, we should go on a field trip because it got the highest score on learning new words. Then we should use flashcards for the words we didn't know after the field trip. Then, we would read about the words and learn a little bit more. Our theory is about why going on a fieldtrip got the highest score.We think that it got the highest test score because it was really fun and that way the kids would want to do more research. Also another theory is that when we were looking at nearys lagoon we saw most of our words in action.

Explanation for Our Theory

We think field trips are the best for learning new words in science because when the students see the words in action then they will be more motivated to learn more words. That way they will develope their knowledge! it is also fun for the students to learn words out of school.It is also fun because if you dont know what something that you found is such as : creatures , plants and other things then you could look at it under the microscope and observe it.

Evidence for Our Theory

throughout our data we found that the field trip was most affective. we have observed the patterns with our data and the problems with our data.we found things such as: students made more than half a columns growth with field trip while 15 for flashcards. this is our evidence.

Other Theories

Another theory that is possible is that if you made flashcards you would still learn the words and know them well, because it got the second highest score. Most of the students found that flashcards was more helpful than the other strategies. So, this means, that flashcards would be hopefully a possible theory for others.

Extending Our Theories

hi

Uses of Our Theory

The main uses of our theory are to tell teachers that to go on field trip would work best because it got the farthest growth in our classes data. We think that it will work out the same way that it worked for us. Another main use is to show to teachers in training/teacher assistants, this data so that they will have an idea about what works best for teaching their students new words.

Teachers should follow these steps to teach students words.

1. Make a checklist for the words you are trying to learn.

2. Go on a field trip and get parents/different teachers to explain and show you the words in action.

3. After that, check off the words you learned.

4.Make flashcards for the words you didn't learn.

5. Read about the words to improve your knowledge about the words.

Limits of Our Theory

One limitation of our theory is that if the teacher really dosen't know the word, can't find an example in nature, or is having trouble giving a definition then maybe the students wouldn't learn the word throughly.

Further Research

one of our questions is why did reading have the lowest score ? This question is important because if we could find out what made the score low then we could try to fix the reason it was low then we would try to make the score higher and then it would be a possible theory. Another question is why were flashcards not as affective? This question is important because we could have made it the most affective if we had more time to study the flashcards , but the only problem is it would not be fair because the other strategies are only for 30 min. and if we spent more time on one of our srategies then the results would not be accurate.

APPENDIX E

Vocabulary Word and Science Content Assessments – Sample Items

1. Word: Ecosystem

How would you define *ecosystem*?

____

____

Think of a situation involving the word as it is used in science. Draw a picture of an ecosystem or use sentences to show everything you know about the meaning of this word (include examples and things connected or related to it):

2. Word: Community

How would you define *community*?

____

____

Think of a situation involving the word as it is used in science. Draw a picture of a *community* or use sentences to show everything you know about the meaning of this word (include examples and things connected or related to it):

APPENDIX F

Word Knowledge Rating Guide Self-Assessment

WORD	I've never seen or heard it before	I've seen or heard it, but I don't know what it means	I can use it, but I would have trouble giving a definition	I think I know what it means and can use it in an example	I know it and I can explain how it's related to other words and concepts
Ecosystem					
Community					
Adaptation					
Population					
Ecology					
Reproduce					
Interacting					
Energy					

Rate this learning strategy: How well do you think it helped you <u>understand</u> the words? (circle one)

Not at all **Not much** **Somewhat** **Helpful** **Very Helpful**

APPENDIX G

Emergent and Predetermined Coding Categories for Responses to Question 3 on the Word Learning Theories Assessment:
How People Learn New Words

Pre_3:Hearing someone else [adults or elders] say word
Post_3:Hearing someone else, listening to conversation [adults or elders] say words
Pre_3:Watch
Post_3:Watch
Pre_3: From reading the word, reading text, books, poems, lists
Post_3:From reading the word, reading text, seeing them
Pre_3:From writing the word
Post_3:From writing the word
Pre_3:By using the word, speaking it, say them
Post_3:By using the word, speaking it, say over and over
Pre_3:Remembering them, memory
Post_3:Remembering them, memory
Pre_3:Writing the word and definition
Post_3:Writing the word and definition
Pre_3:Multiple exposures
Post_3:Multiple exposures
Pre_3:Conversation, communicating, talking with someone
Post_3:Conversation, communicating, talking with someone
Pre_3:Doing a test
Post_3:Doing a test
Pre_3:Seeing words in action, experiencing them, seeing the definition
Post_3:Seeing words in action, experiencing them, seeing the definition
Pre_3:From TV
Post_3:From TV
Pre_3:From music
Post_3:From music
Pre_3:Field trip, museum
Post_3:Field trip, museum
Pre_3:Internet, computers
Post_3:Internet, computers
Pre_3:Games, scrabble
Post_3:Games, scrabble
Pre_3:Homework
Post_3:Homework
Pre_3:study them, practice them, over and over

Post_3:study them, practice them
Pre_3: In school
Post_3:In school, classes
Pre_3:From teacher
Post_3:From teacher
Pre_3:Someone teaches you
Post_3:Someone teaches you, helps you
Pre_3:Parent or guardian
Post_3:Parent or guardian
Pre_3:Outside of school, downtown, playground, vacations, library
Post_3:Outside of school, downtown, playground, vacations, in the car, library, Boardwalk, beach, riding horses
Pre_3:College
Post_3:College
Pre_3:Studying flashcards
Post_3:Studying flashcards
Pre_3:Other people, help
Post_3:Other people, help
Pre_3:Dictionary, look it up, atlas
Post_3:Dictionary
Pre_3:Home
Post_3:Home
Pre_3:With friends, other houses
Post_3:With friends, other houses
Pre_3:Asking others what they mean
Post_3:Asking others what they mean
Pre_3:Learning sounds, phonics
Post_3:Learning sounds, phonics
Pre_3:Spelling, spelling test
Post_3:Spelling
Pre_3:Context strategy
Post_3:Context strategy
Pre_3:Saying definition
Post_3:Saying definition
Pre_3:Number of different theories, ideas
Post_3:Number of different theories, ideas
Post_3:Difference in theories
Pre to post aligns with their inquiry strategies, explicit
Pre_3:Theory aligns with WL literature
Post_3:Theory aligns with WL literature
Pre_3:What it means to "know" a word; incremental

Post_3:What it means to "know" a word; incremental
Pre_3:[Multiple] strategies for learning words
Post_3:Multiple strategies for learning words
Pre_3:Context strategy
Post_3:Context strategy explicitly stated
Pre_3:Word learning situated, context of use, see in action
Post_3:Word learning situated, context of use, see in action
Pre_3:Word learning social activity, sociocognitive
Post_3:Word learning social activity, sociocognitive
Pre_3:Word learning in *and* out of school
Post_3:Word learning in and out of school
Pre_3:Word learning incidental, third party participation
Post_3:Word learning incidental, third party participation

Video Exemplar 6: Strategically and Deliberately Coordinating Strategies for Meeting Learning Goals

This video unit takes place later on in the same lesson as Video Exemplar 4 (p.259). It begins with the teacher telling the class that they will be turning their attention back to working in the Web of Inquiry software, making use of their prior work calculating class averages, creating histograms, and identifying patterns in their data in order to analyze their data. Before beginning to record their prior work in the Web of Inquiry, the teacher posted charts for the class to see, which included the data tables and histograms showing the results from the previous year's class for the same inquiry project (testing each of the three learning strategies, using flash cards, reading, and field trips, as ways to learn new words in science). The scale along the x-axis of the histogram showed average word learning growth for a tested strategy. Growth was measured by students' progress along the performance levels of their co-constructed rubric, captured in the pre-post data from the Word Knowledge Rating Guide self-assessment and the teacher-scored Vocabulary and Science Content Assessment. The range showing the most growth was on the right side of the x-axis (showing students who made 3.01 – 3.5 column's worth of growth on the rubric), the range showing the least growth was to the left side of the x-axis (showing students who actually dropped a level, or who made -.99 – -.5 movement across rubric columns using the rubric). The results for each strategy are shown according to a key. An example of a histogram is shown in Figure 17 below:

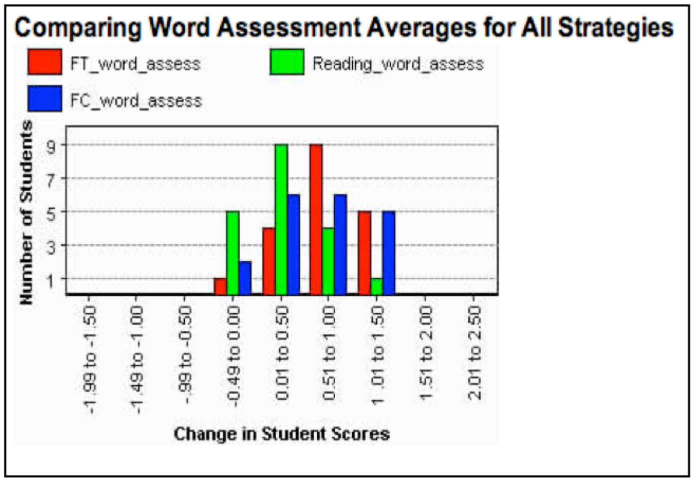


Figure 17. Sample histogram showing comparison of word assessment averages for all strategies

The teacher then guided the students in looking at how last year's class' results compared to their own. Modeling her own scientific thinking about generalizability and the goal for looking for patterns across years, the teacher said, "It's interesting because if the patterns of results are the same as last year, it says something about 4th graders, more than just about us as a group, it says something about our strategies here, this was last year's class…" Students very animatedly responded with "Wooooooo," as they noticed an exceptionally tall bar on one of the histograms. The teacher asked if there was a student who wanted to say something they noticed in the graphs and charts.

Cole responded by pointing out that students were reacting to a tall bar in the middle of the histogram and may be misinterpreting it, explaining that "People are all going "wooo" because reading got so high, but that's actually a bad thing because 10 people only got a half a column [growth], because reading got so high, but that's actually a bad thing because 10 people only got *half* a column."

The teacher clarified Cole's observation further for the rest of the class, explaining how to read the histogram by pointing out that the highest bar represented the most number of people, which was in the middle of the growth scale, and that the farthest right side of the x-axis showed fewer students had made a lot of growth with the reading strategy, explaining, "This is in the middle, the good is up here," and pointing to the left side of the x-axis, saying, "That's what we were calling little growth."

Cole summarized the data further, saying "Most people got low scores, half a column, to which the teacher added that, "Some people made negative growth from reading." The teacher went on to ask the class to compare the results to their own, asking, "OK, so but do we have some of the same patterns, what do you see that's similar to our pattern?" Lena noticed that students using flashcards also made growth, and Leilani reported that field trip did the best overall. The teacher asked the class to raise their hands if they agreed with Leilani's interpretation, and most of the class raised their hands. The teacher helped to point out the patterns in the colors of the bars of the histogram, suggesting "You can almost see it from the color blue, is there more blue on this side, the positive growth side?"

A student responded, "There's barely any blue on the negative growth side." The teacher then asked which strategy did the least well, to which students called out the color of the strategy with the poorest growth overall, and the teacher pointed to the averages for each strategy, asking the students if they were also in the same order, with field trip the highest, flashcards in the middle, and reading the lowest. Students chorally affirmed that this was the case. To summarize, the teacher asked the class, "So are these the same results we got?" and the students responded chorally, "Yeah!" with one student saying "Pretty much…."

The teacher then emphasized to the class that she was a learner along with them and did not know what the outcome would be, though she had her own theories that it would be similar, saying "I had no idea we were going to find this, and I start to get nervous…" to which Jess responded with, "I think field trip is really a good way." This led the teacher to begin problem-posing, returning to the question of why reading was the least effective strategy, asking the class "What about the reading, I mean as a teacher do you think I think reading is important, valuable, and good? Do students think it's a good thing?" Students replied in the affirmative, with one student saying "I like reading, yeah." The teacher asked, to clarify their position, "Is it a good way to learn information?" to which a student replied, "Good for learning information but not really words."

Next, the teacher began to think aloud about her own stance regarding how the reading strategy might best be utilized in light of learning goals. She modeled her own reasoning processes while weighing different theories as she considered a new argument or alternative theory to the idea from the precursor video unit that reading might be good for giving exposure to new words. She also positions herself as a learner along with the students, while also building on and relating back to a student's previously introduced idea of using the reading strategy after first using other strategies to introduce new words, saying "I'm starting to think reading is not the best way to introduce new words in science, maybe it's better to use it to reinforce, who was it that said, maybe it was a good idea to go on a field trip first or make flashcards, then go on a field trip, then read about them? I'm starting to think reading is the thing you should do after, when you've already…"

This idea prompted Jess to interject with her theory about the order in which the strategies should be used, saying "I think you should go on a field trip, then learn a lot a lot of words, then you can read a really good book about it that has all the words, then you can read the book and make flashcards, like *food chain*, read more about it, then make flashcards, then you find out what *food chain* means…" Jess went on to then cite an example from her own experience learning words in both the inquiry research project and in her reading class, "…like yesterday we read '*Ocean Days'* and we kind of figured out what food chain was, so like it was pretty much in order from field trip to reading to flashcards."

The teacher followed up with a question to develop the idea of how to use multiple strategies effectively even further, asking "And do you need to make flashcards for every word?" Many students responded "No, no," The teacher prompted the students to explain this by asking, "Maybe you would just what?"

"Just make flashcards for the ones you haven't learned very well yet," Pablo replied.

The teacher elaborated on this by saying, "Yeah, maybe the ones that are really hard to remember or hard to understand, maybe those are the ones you would go and look up in the dictionary, maybe you don't have to do all of them, you just have to choose the ones that….?" and Jess supplied the rest of the idea, saying "That you need help with." The teacher finished by summarizing and emphasizing the big idea, saying, "So you're strategically using all these strategies to help you learn to the best of your abilities."

In this video unit we see familiar processes that help set the stage for how ideas important to the curriculum are brought up in discussions, and in this unit, many of these ideas have come up before in earlier discussions but in a different context or application. One of the processes here which we have seen regularly in the other video units is the teacher beginning a discussion by posing a problem or an alternative theory to the class and asking them to take a position regarding it. For example, in this unit, the teacher poses the question to students, "As a teacher do you think I think reading is important, valuable, and good? Do students think it's a good thing?". The teacher again has the goal in mind of pushing students to think of alternative theories that could explain, coordinate, and perhaps reconcile their thinking about the value of the reading strategy, compared with the other strategies, using the evidence from their data. As before, it is in response to the teacher's problem posing that a student brings up an important idea. In this video unit a student is the one to remark that reading may be "good for learning information, but not really words." This is important because it is a student who offers this observation, not the teacher, and it is offered in a context in which the students are weighing the utility and value of reading in light of their evidence. It also shows that the student is coordinating theory with evidence in critically evaluating the reading strategy. This comment from the student also leads the teacher to reason aloud about how her own stance is shifting as she considers alternative theories, positioning herself as a learner along with the class, modeling her thinking processes as a form of cognitive apprenticeship. In so doing, she builds on and credits a student's previous idea of using the reading strategy later in a sequence of using multiple learning strategies, asking "who was it that said that maybe it was a good idea to go on a field trip first, or make flashcards then go on a field trip, then read about them?"

This reasoning by the teacher provokes others to consider whether reading should be early or late in a sequence where multiple learning strategies are used, with Jess interjecting to share her idea of a sequence she thinks is best. What is also noteworthy here is that, in addition to an elaborate description of the sequence she thinks should be used (I think you should go on a field trip, then learn a lot a lot of words, then you can read a really good book about it that has all the words, then you can read the book, and make flashcards, like food chain, read more about it, then make flashcards, then you find out what food chain means…), Jess connects this to her own experience and offers it as a form of evidence for her theory, when she reflects on how "yesterday we read ocean days and we kind of figured out what food chain was, so like it was pretty much in order from filed trip to reading to flashcards."

Many of the ideas in this video unit were previously brought up in prior discussions. Some of these include the teacher referring to the idea that reading isn't the best strategy for learning new science words, and was discussed in the previous video unit, the idea that reading is useful for a particular goal, such as having multiple exposures to words or developing an awareness of new target words (which emerged from the discussion in Video Exemplar 4 with Ella, Meggie, Gabe, Efrain, and the teacher). The teacher also referred to the previously introduced ideas that strategies can be used in combination, and that multiple strategies can be used sequentially and strategically to improve how you learn new words in science. This idea can be traced back to Pablo's idea early on in the questioning and theorizing step of their inquiry, that you could use multiple theories and use them sequentially, as well as to other instances where the idea to use multiple strategies (even making your own) came up. In this video unit, the teacher asked the class which student initially brought up the idea of using learning strategies strategically in a specific order, but now proposes a theory for why one might benefit from using reading last. This idea was further refined by Jess who went on to present her own idea for what the order should be. She builds on, elaborates, and extends the previous idea which the teacher had reintroduced and developed further while coordinating theory with evidence. Jess developed the idea further by proposing a process and order for learning and coordinating strategies intentionally and strategically, giving an example from her own experience shared by the class from the day before. Another important idea in this video unit was the idea of learning how to learn, that you can improve yourself as a learner, learning how to be an effective learner by being strategic in using strategies as tools to help you learn. While this was an idea brought up early in the curriculum, in this video unit this idea was made explicit as a process and implied that learning how to learn is a desirable goal.

There were, however, some new ideas in this unit, including that going on a field trip is the best way to introduce new scientific words (Jess in this unit). Finally, towards the end of the discussion one of the more important ideas is introduced, that of being strategic in monitoring and choosing which words to focus on in using the flashcard strategy, developed in an interchange between Pablo and the teacher. Pablo suggested, “just make flashcards for the ones you haven't learned very well yet" as a response to the teacher’s problem-posing in asking the question, "Do you need to make flashcards for every word?" while discussing the use of multiple strategies sequentially. At the end of the discussion, both the teacher and Jess elaborated on

Pablo's idea of making flashcards for select words, with the teacher suggesting to make them for words "that are hard to remember or that are hard to understand," and Jess suggesting to choose the ones that "you need help with." Here we see how both Pablo and Jess help clarify an idea when they suggest what words to focus on in using the dictionary and flashcard strategy.

The teacher ended the unit by making it explicit that this is an example or process of using strategies strategically to help improve your own learning. While using learning strategies to be efficient in your learning had been brought up early on in the project, with Jess suggesting that learning how to learn can help you to learn "faster, easier, and better," here was a concrete example of how to apply that idea using the three strategies they studied in a way that was consistent with their data analysis.

Many of the key processes in the collaborative development of ideas which have been evident in prior video units are found here as well. In addition to the teacher's problem-posing and thinking aloud while reasoning, the teacher and students build on, elaborate, extend, and clarify ideas as well. Examples are also used, such as when the teacher provides an example of a sequential use of strategies so as to illustrate using them strategically to become better learners, and Jess gives an example from her experience in class using strategies sequentially in a way that was effective for her in developing a more sophisticated understanding of a scientific concept and its word.

One of the most essential, dynamic processes we have seen in the architecture of collaboratively building ideas is that of constructing a scientific and theoretical argument. In the context of developing an argument, ideas have first been offered and take root in the learning community, and are taken up in later discussions as they become more refined, elaborated upon, and becoming coherent theories supported by evidence informed by findings from students' data as well as personal experience. In the discussion as a whole, the participants collectively make an argument for why multiple strategies should be used for meeting different goals, such as introducing a new word/concept versus learning more about it, as well as for why reading shouldn't be the strategy used for introducing brand-new scientific vocabulary for the first time, and why certain strategies should be used first or later in the sequence of strategies for word learning. The teacher and Jess propose a process or mechanism in making an argument for improved word learning, arguing for using multiple strategies to learn words more efficiently and effectively, and later in the discussion the teacher and students together make an argument for why certain words should be targeted for using the flashcard strategy, as well as for which words they should be. The teacher pushes for alternative theories to be considered by problem-posing and asking if the teacher or students see reading as valuable, important, and good in the face of two years worth of evidence suggesting it is the least effective learning strategy.

We also see in this unit how big ideas that are new or which resurface and are further developed evolve in response to the teacher's request for a theory or argument to explain the evidence from two years worth of data showing reading as the least effective strategy. In addition, we see how one student, Jess, in so doing, offers evidence to support her theory when she provides an example from the previous day in class for why reading is valuable to use as a strategy later on in the sequence when applying multiple strategies. In this process, students critically evaluate alternative ideas while coordinating theory with evidence, to arrive at a conclusion, coming up with theories to explain the results and more effective learning approaches based on the evidence present in their results. For instance, much of the discussion involved looking at the best use of the reading strategy given the findings that it is the least effective and constructing an argument and rationale for why it should be used the way it is being proposed.

Lastly, in considering ways in which students demonstrate their appropriation of ideas that are important to the curriculum, we see evidence of students using them in new contexts. This was the case when Jess used the idea of applying multiple strategies flexibly, strategically, and sequentially, when she gave an example from another academic situation—reading class the previous day. We also see in this video unit how students give, use, and refer back to evidence of earlier ideas in constructing their arguments. Jess shared how they learned more about food chains from reading following first using a number of other strategies, including a field trip, to first gain exposure to the targeted scientific terms. And one of the most important ways students could show their appropriation of big ideas was also apparent in this video unit, by having use them ideas as tools for their own purposes or in meeting their own learning goals in another context. Jess does this when she proposes the sequential use of strategies in a specific order, providing evidence from reading class. By suggesting to target flashcards as words "that you need help with," she demonstrates her further metacognitive capabilities in suggesting a way of actively monitoring and managing one’s own learning needs and strategy use as tools for meeting learning goals.

Video Exemplar 7: Collaborating while Refining and Applying Big Ideas within a Smaller Research Group—Using Multiple Strategies Sequentially to Meet Learning Goals

In this short video unit, students are working in their research groups to complete the steps in the Web of Inquiry of Patterns in Our Data, Findings, and are moving on to create a Current Best Theory based on their results while the teacher circulates among the groups. In the beginning of the video unit the teacher is present, working with a small group of three students, and then the majority of the video unit shows the small group carrying on with their work without the support of the teacher. The teacher prompts the students in the small group to come up with a Current Best Theory, by saying "Now you say what you think and why, and you can brainstorm.” When a student clarified if they should talk about “our ideas about which strategy we used,” the teacher suggested, "Yeah, maybe if you’ve used which ones, maybe you’ve used more than one, maybe you’ve used them in a certain order, because you think it might be helpful, and you say why..."

Leaving the group to work on their own, the students set out to come up with a Current Best Theory. Adriana got the group started by reading and typing what they had so far, “We think that when you are learning words in science, you should first go on a field trip, OK…”

Janey then suggested what to write next, “After you take the field trip and know about them, then use flashcards for the ones we don’t know and then read about them. So, OK…” After finishing typing their theory, the students discussed switching roles in the group and who should type next.

Ella then continued, saying “Then we should make flashcards to see the words we didn’t know on the field trip, last thing, finally, lastly, then we would read about the words and learn a bit more. Just write that we think that…OK, now let’s fix our errors.” After correcting typos, Ella said to her group, “Now we have to make another theory, like, let’s see, um I had one, I just had one, OK here’s a theory, we learn words but then we forget them, like really hard words, like when you learn a word, like when you learn it, and you see what it means, and you know what it means, and then you forget, like me with that word, I forget which one it is, then I forgot it,”

“Seed dispersal?” Janey suggested.

Ella responded with “No, no, no, like it was ecology, yeah ecosystem, I used to know what it means but now I forgot, so that’s a theory, we’re good.”

Janey then pushed for the group to come up with an explanation for their theory, reading from the Web of Inquiry “suggest a mechanism why you think this theory happens, you may want to include a model or diagram to make it clear. I don't really see…"

Adriana suggested, "We could make a bar graph."

"Let's make one," Janey agreed.

Ella replied, "Too confusing, let's try to…see there is a spot where we can make some graph. After talking off topic, the group returned to their task with Ella reading again, "Suggest a mechanism or process that predicts, OK, so suggest, a mechanism or process that explains why the things we predicted, asking her group what is a process that explains why?" before the camera session ended, ending the unit.

In this unit, the teacher begins by asking the group to reflect on their experience and evaluate their experiences by thinking and reflecting critically while integrating the idea of using strategies in a particular order. She prompts them to use their evidence from their inquiry to make an argument, for what is most helpful and to explain the mechanism ("and you say why"). After leaving the group, the students took up the previously introduced idea of applying multiple strategies sequentially, offering it as their Current Best Theory and proposing a strategic sequence for using the strategies most effectively. The ideas in this video unit are ones which were introduced in previous discussions, and which students are returning to in their current discussion—and in developing their theories—in their small group. The idea of using multiple strategies sequentially was first introduced early on in the curriculum by Pablo in a whole class discussion during the questioning and theorizing step of their inquiry. The idea became more refined with concrete examples, evidence, and a rationale to support a particular order in using the strategies over time. This was evident in Jess' contribution in the previous video unit, which had taken place five days earlier. Now we see how the idea of using multiple strategies sequentially returns in the small group as they contemplate what they think the best ways to learn new words in science are and why. The students build on the idea by aligning the learning strategies with the goals they are best suited for in the sequence of using them as they create their Current Best Theory. This includes learning experientially with a field trip with an expert to help point things out and explain them first for developing a deeper, enduring understanding, followed by using flashcards for just the words they still don't know or didn't learn about on the field trip, and then reading about them "to learn a bit more." The students incorporated the idea from Pablo in the previous video unit to use the flashcard strategy strategically in focusing on and actively choosing words "that you haven't learned very well yet." This shows how ideas offered by students have been appropriated by other students in developing their word consciousness and metacognitive capabilities as they construct theories in which they demonstrate a flexible and strategic use of strategies for meeting diverse learning goals.

Another earlier idea, which returned in the small group discussion, came from Ella, both originally and in this video unit. Ella refers to a previous idea which stemmed from her observation and reflection which she shared in the form of a question, wondering why using the flashcard learning strategy led to such short-term knowledge of word meanings. Here Ella suggests her other "theory" as an alternative theory, that you can learn new words and what they mean, but that the knowledge is not necessarily enduring.

In all cases where students brought up previously ideas for use in their small group, students reintroduced, referred to, and built upon the ideas of other students. Janey and Adriana refer to Pablo's idea of using multiple strategies sequentially after the teacher also refers to the idea while prompting the students to reflect on their own experiences using the learning strategies, saying "maybe you've used more than one, maybe you've used them in a certain order." Janey, Adriana, and Ella also refer to Paolo's idea of using the flash card strategy strategically in choosing and focusing on certain words that still haven't been learned well, and Ella reintroduces her own idea as an alternative theory for consideration by her group. From this we see how working in small groups, even without the teacher present, students have opportunities to reintroduce, build on, and take up ideas offered by other students in earlier discussions, putting them to use in their own thinking as they construct their own theories and in light of their individual group's initial theories, research questions and hypotheses.

Some of the important processes of collaborative development of ideas apparent in whole group discussions are present here in a small group working independently as well. We see how students build on, elaborate, and extend others' ideas, fitting the context of their inquiry, by taking them and elaborating on them in developing their group's Current Best Theory and alternative theories to explain their findings. Students also use examples to help communicate their ideas, as when Ella refers to her own example and experience learning and then later, forgetting the meaning of a word learned through the flash card strategy, offering her example as evidence to support an alternative theory for their group that "we learn words but then we forget them" to explain their data from the flash card strategy.

Furthermore, the students in this short video unit, working independently without direct supervision or support from the teacher, show evidence of processes used in constructing a scientific argument. Before they begin, Janey showed an awareness of the need to provide evidence in support of a theory, idea, or argument, when she clarified with the teacher whether they were being asked to reflect on the evidence from their inquiry experience, coordinating theory and evidence, and whether they should be thinking about “our ideas about which strategy we used.” First, they proposed an idea or mechanism for what is the most helpful and effective way to learn words, that combining learning strategies in a specific order would be most effective based on the strategies meeting different learning goals. Next, a student proposed an alternative theory about memory and learning words. While each theory is offered in the inquiry context of explaining their findings, in both cases the students don't explain how or why their theory or mechanism works (despite the teacher’s prompting to “say what you think *and why*,” and with her prompt emphasizing the need for providing an explanation, by saying again before leaving them “and you say why.” At the end of the unit the group struggled with thinking about "coming up with an explanation for our theory" and two students wanted to use a bar graph as a diagram, but the group gave up on this idea as "too confusing" and eventually became off task ending the unit. This shows that students, while capable in whole class and small group settings working with a teacher’s support, providing an explanation for their theories is still a challenge for students when working independently. However, the students in this small group show that they are evaluating alternative ideas, coordinating theory with evidence to arrive at a conclusion. They did attempt to introduce and consider alternative theories ("Now we have to make another theory, let's see…OK, here's a theory….) and gave evidence in the form of experience in support of their theory. Yet, how this alternative idea served as a competing theory or a counterargument to the idea of learning best from using multiple strategies sequentially, requires inferring from previous discussions where the idea was first introduced, and that using certain strategies—namely flashcards—would not necessarily lead to deep and enduring word knowledge.

Lastly, given that students in the small group in this video unit were taking on the specific task of coming up with a Current Best Theory for their Web of Inquiry project, it would be unexpected to find many instances or examples of students appropriating big ideas by extending them to other domains, putting them to use and applying them in their own lives or in other contexts. While we may not find evidence of students offering a big idea to explain, illustrate, or give an example of a *new* phenomenon or context, we do see how previous ideas have been appropriated by the group in constructing their Current Best Theory. One of the most visible ways in which this happens is by students giving, using, and referring back to evidence of an idea, and what is noteworthy here is how the students in doing this, build on the ideas of other students. The small group uses previous ideas in developing their formal theories for their group project report, specifically in their Current Best Theory and Alternative Theories to explain the patterns in their data. The teacher also brings up a previous idea (the idea of sequencing strategies strategically) to prompt students' thinking, part of scaffolding the group work for coming up with a Current Best Theory. In addition to making use of the idea of learning new words by using multiple strategies in a specific order, the students are using Pablo's idea of strategically using the flashcard strategy for certain words as part of their sequence of strategies based on learning goals each strategy is best suited for. And most relevant here is that their theories, rationales, and how they articulate them, in both their CBT and their alternative theory, show evidence of students thinking strategically and flexibly about ways to use strategies as a set of tools for improving their own learning, and show their growing awareness in critically evaluating whether and how different strategies are actually accomplishing their own learning goals.

Video Unit 8: Synthesizing in a Small Group Working with the Teacher

In this last video unit exemplar, we see some examples of teaching practices and processes used to support students while working in smaller research groups. While the inquiry was conducted as a whole class, and this is the context in which much of the important learning and big ideas were introduced, developed, and applied, students in their small groups had greater flexibility in coming up with initial theories and research questions, and from there, developed their own hypotheses, research plans, analyzed data and coordinated theory with evidence to arrive at a Current Best Theory based on their results. The small groups also allowed everyone greater participation and accountability for coming up with ideas and engaging in completing the steps of the Inquiry Cycle within their group, while still having the support of their teammates, as well as that of the teacher when visiting groups. The teacher's own assessment is that scaffolding student learning when visiting groups was important in helping students to engage in and develop an understanding of inquiry processes, including theorizing and coordinating theory with evidence.

This video unit takes place towards the end of the curriculum when students were mostly working on finishing their projects in their groups. The teacher was working with a small group of two girls, Lena (an EL) and Jess (an EP), on the Synthesizing step of the Inquiry Cycle, and on coordinating their theories with evidence to come up with a Current Best Theory. The teacher began by asking the students what step of the Inquiry Cycle they are working on, to which Lena replies, "We need to say why," showing that Lena was aware of the goals for her group's current work.

The teacher then read aloud the students' Current Best Theory from their project report, "We think our best theory was the field trip. Mostly everybody did good on the field trip. And mostly everybody moved a column's growth because most people improved." After reading, the teacher prompted the girls with their next step, which was what Lena had already stated, to explain the reasons for their Current Best Theory, saying "So now you're going to say why, so what I want you to do is, see here…" and, pointing to the evidence they cited in the text of their Current Best Theory (referencing that most students made a column's worth of growth using the field trip strategy), said "…that's your evidence, right? I want you to say why you think it did best, what is it about the field trip, so you might say we think this is because…. why is the field trip a good strategy, why did it do the best? It did the best, but why? What is it about the field trip?"

In response to this series of questions prompting the students to think of an explanation, reason, or mechanism for why the field trip was most successful, Lena immediately offered her ideas, saying "We saw examples in nature and got to experience [them]."

The teacher modeled using a language frame sentence starter with Lena's idea, saying, "So you could write, *we think this is because*, and you write what you said." The teacher then turned to Jess and restated Lena's explanation for their

Current Best Theory, asking Jess to build on it, saying, "See Jess? She thinks it's because you got to see examples in nature and experience it, is there any other reason why you think?"

"You get to learn more about nature," Jess replied.

The teacher pushed Jess for more of an explanation specific to the field trip as a strategy by playing the skeptic and offering a counterargument in the form of a question, saying, "Couldn't you learn more about it in a book too?" followed by the question, "So what is it that's different about it?"

"Yeah, but the book could just be showing stuff and the field trip could show what it's *really* about," Jess explained.

Now the teacher encouraged Jess to clarify her idea by elaborating further, repeating her idea as a question, "Show what it's really about?" and Jess explained her idea using an example, saying, "Like with a movie like Spider Wick, Spider Wick the movie is really different than the book."

To this the teacher asked a clarifying question that directed Jess back to explaining the rationale for her theory, "So you say you think you could learn more by seeing, more about what it is you're learning about?"

Jess affirmed this, saying "You can learn more about it by seeing it rather than just by reading about it."

Seeing how the two students' explanations worked together, and considering how Jess' idea (you learn more by experiencing than by reading) built upon her teammates precursor idea (you learn by seeing examples and experiencing them), the teacher proposed, “This is what I want you to remember to write, so we think this is because you can get examples of the words by seeing it, OK, and you also said experiencing it, and then um, what you just said, you think you can learn more about it by seeing it…”

Jess jumped in to state her idea again, adding, “By seeing it instead of reading it.”

Reflecting for a moment, the teacher shared with the students that Jess’ idea was a new one, explaining how rather than arguing that one strategy was better for its own merits, Jess was arguing for why one was better as a strategy compared to the other, saying, “That’s something no one’s said yet Jess, that you can learn more about it, it’s not just a better way because, you’re learning more from it than you could from reading about it.”

Jess developed this idea even further, explaining how learning experientially as they did using strainers and tubs to collect aquatic insects from the wetland to study was different than reading about them, saying “But you couldn’t get tools like that in a book, and just go in the water and scoop up insects like that in a book, you couldn’t do that, but you can on a field trip, so you’re learning more about the stuff on the field trip than reading about it in a book ‘cause the book is just going to tell facts about it.”

Wanting to make sure that the students captured all of their ideas in their written report, the teacher prompted them with "Can you write that, can you get all that idea in here?"

Lena offered to type and they set out to their task with Lena telling Jess, "You tell me what to write OK?" and Jess telling Lena, "Spell how you think it's spelled." The teacher then left, and Lena began with "You can learn new words…" and Jess added "You can learn more things on a field trip than in a book, on a field trip than in a book….next, you cannot look and touch creatures, that can help you learn new things…," and the video unit ended.

In this video unit, the idea being explored and developed is the reason why students think going on a field trip is a more useful strategy for learning new words in science, providing an explanation for their Current Best Theory. To begin the unit, the teacher, after reading the students' Current Best Theory, supported them in thinking of an explanation by first referring to the evidence that the students themselves had included in their theory, ("…that's your evidence, right?"). By doing this, the teacher made the relationship of theory to evidence explicit, and supported the students in making this connection by asking them to "say why you think it did best, what is it about the field trip," as well as by offering them a thinking prompt in the form of a sentence starter to help prod their thinking, "So you might say, 'We think this is because…." Finally, similarly to the way big ideas developed in prior video unit discussions with the whole group responding to the teacher's problem-posing, here the teacher asked a series of questions with the goal of guiding the students to take a position and argue for it, and having drawn their conclusion based on their evidence, to provide a mechanism or explanation for their theory, asking the students, “Why is the field trip a good strategy, why did it do the best? It did the best, but why? What is it about the field trip?”

The big ideas in this unit were offered in the context of developing a Current Best Theory, with Lena first offering the idea that students learned best with the field trip strategy because they got to see examples in nature and experience the words. Lena, in offering this initial idea, was reintroducing an idea which came up in multiple class discussions over the course of the students’ inquiry, and which was first brought up weeks earlier when students were theorizing about the best ways to learn new words in science, and deciding on theories to test in their research design. In that first discussion, Leilani, responded to the teacher’s question, “What is it we would need to do as a class to be able to really know a word in science, like knowing Ocean Side carnival,” by suggesting they would need to not just look it up in the dictionary or on the internet, but that they need to be able to picture it, hear it,” and Jess added, “Smell it…” The teacher then gave examples, “What would we do? Let's say we needed to learn about rivers? Different types of soils? Rocks?” Jess added, “To explain them,” and that “We could read a book about them,” and the teacher, pointing out they had books, asked what would be “better than just reading about it,” to which Angélica (an EL) suggested, “Maybe we could share a few ideas.” The teacher building on this and connecting it to learning from more expert others said, “Learn from people who know.”

Jess suggested “Learn from your teacher,” but when the teacher pushed for more, saying “We've got this idea—learn from the experts that know about a topic—but to see it, smell it picture it,” Leilani suggested the idea that “Maybe you could go to a place where it is found and see how it is,” which began a discussion of how seeing examples in nature is different from reading about them or seeing photographs. This early discussion included the counter argument that there may be times when you might see something in a book that would be very difficult to see in real life, and that reading in a book “might be better depending on what it is you’re trying to learn.”

Now bringing up the idea here as the rationale for her Current Best Theory based on their evidence, Lena shows a form of appropriation of the idea introduced so much earlier in the curriculum. She uses the idea in constructing an argument about a theory or mechanism for predicting the best ways to learn new words in science in school based on evidence, and in drawing their conclusion, arguing for it in a way that is compelling to others. When developing their initial theories before designing their research, many of the explanations developed for why experience was beneficial for learning were offered without any evidence to support them. In contrast here, Lena offers her explanation—in response to the teacher’s request to take a position explaining the reason for their Current Best Theory and to argue for it— based on their evidence. When the teacher asked Jess to build on the idea, Jess did so by offering an additional idea that learning experientially allows you to learn more than reading does. Jess and the teacher developed this explanation through a collaborative process, which included the teacher asking Jess to elaborate, clarify, and extend her idea with further explanation. One strategy the teacher used to do this was to restate Jess' position as a question, asking for more explanation, as when the teacher asked Jess, "Show what it's really about?" and "So you say you think you could learn more by seeing, more about what it is you're learning about?" Another strategy the teacher used to do this was in taking on the role of a skeptic, asking questions which directed Jess to convince or persuade her of her argument, for instance by asking, "Couldn't you learn more about it in a book too?"

In addition to problem-posing, clarifying, elaborating, and extending ideas as familiar constructive processes for collaboratively developing ideas in this unit, we also see examples of how students develop and communicate ideas. In this video unit, it is a student, Jess, who makes use of examples, first in explaining her idea that one can learn more from learning experientially than from reading, with the example "Like with a movie like Spider Wick, Spider Wick the movie is really different than the book." She goes on to give examples from their own experience learning experientially to illuminate the mechanism for how one can learn more from a field trip than from a book, saying, "But you couldn't get [tools like that] in a book, and just go in the water and scoop up insects like that in a book, you couldn't do that, but you can on a field trip, so you're learning more about the stuff on the field trip than reading about it in a book 'cause the book is just going to tell facts about it."

Because the students' research questions were often framed as a test of two competing theories, it is not unique to Jess and Lena's group that in their Current Best Theory they provide a rationale for their theory in comparison to another strategy used in testing their research question. However, Jess offered a new idea, prompted by the inquiry step of explaining their Current Best Theory, when she articulated a thoughtful reason and explanation for why one learning strategy was more effective than the other, and why it afforded an opportunity to learn more from it. Finally, this explanation and use of examples also shows how Jess, like Lena, based her explanation on evidence from their research. Jess' explanation complimented Lena's, as Lena referred to the pre-post data from the whole class' performance as evidence, while Jess drew on the more qualitative data source from their experience engaging in the learning approach itself. Furthermore, Jess also shows her own appropriation of the initial experiential theories introduced in the early class discussions when students were brainstorming best ways for learning new words in science. She does this by putting these experiential theories to use in constructing an argument explaining her Current Best Theory and mechanism for learning words in science *by drawing on her own experience as evidence* to support it. In addition, it is noteworthy that in the early discussion, Jess contributed the idea that "we could read books about them" as her first idea for how to learn science words, a position which she argues against based on the evidence from their data.

Finally, we see in this unit how processes of argumentation are central in the collaborative development, migration, and appropriation of ideas important to the curriculum, as well as in the teaching practices that support their development. Firstly, the students' chief goal and the function of their discussion in this video includes proposing an idea or mechanism to explain a phenomenon as they construct an argument and explain their Current Best Theory as a part of their inquiry process. They make their argument for experiential learning as the best way to learn new words in science, and are goal-driven in response to the teacher's problem-posing, with the purpose of coming to a conclusion and persuading others, in this case the teacher, of their position. Alternative theories are introduced by the teacher, who poses them in the form of probing questions while playing the role of the skeptic. It is through this process of considering alternative theories that Jess further develops and elaborates on her theory and provides evidence in support of it. Students not only begin the unit—and their Current Best Theory—by offering evidence for their theories, the use of evidence is itself central to their appropriation of ideas, as they use evidence in constructing arguments for their theories and previously ideas by coordinating their theories with evidence to support them. It is in the process of thinking about their own experience, evidence, and learning while engaging in the Web of Inquiry step of coming up with a Current Best Theory for the best way to learn words in science that students appropriate big ideas. We see, for example, how both Lena and Jess use and apply previous ideas into their own group's practice in meeting the goal of the Web of Inquiry step of providing an explanation for their Current Best Theory, both making use of and referring back to a previous idea in constructing their own theory for the best way to learn new words in science, and offering multiple sources and types of evidence to support it. Since the students' explicit goal in this video unit centered on completing the step of the Inquiry Cycle where they provide an explanation for their Current Best Theory, we don't see examples of students putting big ideas to use in new contexts as a form of appropriation. However, we do see how the students put ideas to use in considering how they best can learn in the context of their inquiry research in learning new words in science, and how they appropriate ideas by using and referring back to evidence of them in attempting to accomplish their goals for inquiry in their small group, and how the teacher supports this process.

APPENDIX I
Curricular Unit Plan

The following was the plan developed by the teacher on the outset of teaching, to be used as a guide for the curriculum. While the sequence and ideas were generally adhered to, lessons did not correspond to the days (often taking longer) and were adapted to take into account and respond to students' needs and ideas.

Vocabulary and Academic Language

Words were culled from two state-adopted fourth-grade science textbooks to form a corpus of academic language and vocabulary for the content learning themes of ecosystems, food chains, and interdependence. The words culled include a variety of words that might be considered 'academic language' or challenging for a fourth-grade reader. The words focused on in this unit include "core" vocabulary words, or words that represent important ideas and concepts that are central to the life science content area being taught. After culling words from the science texts, the list of words was narrowed to focus on "core" vocabulary words. Words that appeared in both textbooks were given high priority, and words that appeared in multiple sections of the textbooks by theme (ecosystems, food chains, interdependence) were noted so that they would only be included in one thematic word list. Next, words that students were previously taught during the current school year and which appeared on the science "word bank" bulletin board on the classroom wall were taken out. Finally, from these word lists for each content-specific theme, a final list of twelve words per theme was formed after collaboration with the participating teacher.

Assessments

- Pretest and Posttest Data:
    - Inquiry pretest and posttest
    - Theories of word learning pretest and posttest

- Assessments that will be used to evaluate students' knowledge of core vocabulary and conceptual understanding of key concepts related to core vocabulary:
    - Word knowledge rating guide self-assessment as pretest and posttest with student reflection as part of posttest on learning strategy used
    - Conceptual content assessment for vocabulary words, combining word-level information with big ideas the word represents

- Other sources of assessment:

- Qualitative semi-structured open-ended interviews
- Students' inquiry projects
- Video analysis

Week 1

Day 1: Introducing the Project, Web of Inquiry**, and Brainstorming Theories**

Whole Group

Goals:

- Access students' preexisting theories of learning words that they already have, and frame the entire inquiry around investigating students' theories of word learning
- Begin by eliciting from students what they believe it means to know a word, and how we know when we know a word.
- Co-construct way of measuring how well one knows a word

Intro: Set the Stage for the Project

- Introduce Inquiry: We are going to be scientists, learning the way scientists learn, through inquiry (ask what inquiry sounds like, to inquire). We will be investigating how we learn words.
- First we need to think about what theories we already have about learning words.
- *Define Theory:* A theory is an idea that explains something or predicts what will happen. A theory says how the things are related to one another. A theory also includes an explanation for why these things happen.
- An example of a theory about listening to music when doing homework is "listening to music with words or *lyrics* when you do your math can distract you because you start to listen to what the words say."

Brainstorm Theories:

- These questions may seem familiar (pretest), now we are going to collaborate (what does that mean? Why is it important or helpful to work together?) to come up with as many different theories as we can about learning words.
- Ask: Why do people learn new words? Give a moment for quick write and reflect "think of a time when you learned (a) new word(s). Why did you learn it/them?" Students share out [chart responses]
  - To understand something (problem solving)
  - To communicate with others

- To learn about something
- To become part of a community
- To describe experiences
- To develop writing, improve vocabulary

- When do people need to learn new words? Think of times and events when learning new words might be important. Think of a time when you learned new words, what was the situation?
  - When you are having a conversation
  - While reading
  - Learning a new skill
  - Learning a new language
  - Watching T.V. or a movie
  - When you are part of a group
  - School
  - Job, training
  - Camps, museums, field trips, other programs

- What does it mean to know a word? How do we know when we know a word?
  - Can pronounce it
  - Can read it
  - Can spell it – aside why is spelling a word the same way important? Why are names/labels important? [To communicate about the same thing and know we are all referring to/meaning the same thing]
  - Recognize it
  - Can picture it
  - Know what it means
  - Can use it in context
  - Can understand it when it's being used by someone else
  - Can think of things that are related to it (think of ex. elephant or volcano) or connect it to world knowledge and experience
  - Can use it to build knowledge

- How can we show that we know a word?
  - Can use it
  - Can describe it
  - Can picture things it's related to
  - Can explain it

- Can define it
- Can read it

- How do people learn new words? Scaffold students' development of different theories of word learning that students may then investigate and hypothesize about by….

  Scenario 1:

  A child goes to out of town to visit her family who owns a ranch, and she stays on that ranch for a few weeks. At first, they discuss the operations of the ranch and use technical words that the child doesn't understand and maybe has never heard before, but she listens and watches as the family members use these words while also performing activities and tasks on the ranch. Over the course of the visit, the child learns how to perform some of the jobs, first by observing, listening, and assisting her family members, and by the end of the few weeks she realizes not only has she learned a lot about ranching, but that a lot of the words she didn't understand at first she now understands in the context of the daily operations and conversations that everyone has while working together to run the ranch. She realizes that she herself is now using those very words that just a few weeks before were unfamiliar.
    - How do you think this girl learned all the new words?
    - What do you think was important, helpful, or useful for her in learning the words?
    - What do you think might be most helpful for anyone learning a set of new words?

How do we learn when…

Scenario 2: Working in a group and the members are using words they don't know…

Scenario 3: Learning a new skill, sport…

Scenario 4: Learning a new word for something you already know (word as a label for known concept) ex. gato, soil

Scenario 5: Learning a new concept entirely, ex. photosynthesis or allelopathy

Scenario 6: You need to know because of a situation, ex.

- Having a baby
- Learning a new game
- Being in a club, boy scouts, girl scouts, team sports
- Church, catechism class, temple, etc.
- Cooking
- Gardening, farming, agriculture

- Work, jobs, parents talking about their work
- School, subjects, science demands lots of new words (Mary Bud Roe)
- Sick, illness, medical terms

Scenario 7: Suppose you are trying to teach someone some new words, what would you do?

- Now, if in school it is our job in fourth grade to learn about ecology, and in science there are more specialized words and terms than other content areas. We are going to be scientists investigating whether certain ways of learning words are better for learning new words in ecology.
- What are some different ideas for how we can learn scientific words and concepts of ecology?
- We will try three different strategies for learning science words and concepts. What are some ideas for how we can measure how well we learned the words?

Introduce the Project: We are going to investigate different ways of learning words and concepts in science are better than others. First, we will come up with our own theories for how we learn words/concepts in science.
Introduce the Web of Inquiry:

- Logging on, laptop guidelines
- Navigating in the notebook:
  - Sections of the notebook
  - Entering workspace and saving work
  - Types of advice (examples, questions, sentence starters, definitions, strategies to try, motives)
  - Tools
  - Goal assessments

- Begin Research Topic and Variables

Introduce variables: Define, give example from music and inquiry (manipulated, responding/dependent, controlled)

- List all the things that might affect the phenomenon that you are going to study. Include variables you can change and variables that might be affected by those changes. Also include other variables that might have an effect.
- Variables we can *manipulate* or *change*: (things we can change to affect

how we learn words): How we study or learn the words, strategies, ways we learn (flash cards, dictionary, teacher, group, projects, etc.)

- Variables we will control or keep the same: How many words, how much time we spend on each set, the type of words (difficulty), whether we have been taught it before or if it's new
- Variables we will measure: How well we learn the words

Day 2: Questioning and Theorizing

Goals:

- Students in groups brainstorm theories, possible questions, and come up with a specific research question

Introduce the goals for the session: Coming up with theories and research questions

- Share that in order to come up with questions we can all ask and study in our groups, we need to decide on what our three strategies for learning new words/concepts in science will be.
    - Refer back to the charts on why, when, how we learn words
    - Ask students for ideas they have about what a best way to learn new words/concepts in science is?
    - What are three different learning strategies we can try out and compare to see which is the best one?

- Students work in groups to generate theories and research questions, completing step one

** Remind students to use advice and complete goals assessments **

Day 3: Hypothesizing

Goals:

- Students in groups come up with hypotheses

Introduce the goals for the session: Coming up with hypotheses

- Have students look back at their question, explain they will come up with three different possible answers to their question that they think they might find from doing the investigation

  - Question: Does learning new words with flashcards lead to a deep understanding of the word/concept, or only help you learn the definition?
  - Hypothesis: Learning new words with flashcards helps you learn definitions, but does not lead to a deeper understanding of the word/concept.
  - A different hypotheses: Learning new words with flashcards helps you to really understand the word/concept and the definition
  - Another hypothesis: Learning new words with flashcards helps you to learn the words that you study, but it depends on which words you study and how long you study them.

- Students work in groups to generate hypotheses, completing step two

** Remind students to use advice and complete goals assessments **

Day 4: Investigating Our Hypotheses

Goals:

- Begin step 3, Variables and come up with assessment ideas for measuring how well we know a word

- List the variables we will manipulate or change:
  - The way we study the words
  - Strategies for learning words
  - Flashcards
  - Textbooks
  - Collaborative inquiry

- List the variables we will control or keep the same:
  - The number of words
  - The kind of words
  - The time we spend learning the words
  - How we measure if we learned them or not
  - How ‘new’ the words are

- List the variables we will measure:
  - How well we learned the words

- How will we measure how well we know the words? Now we need to figure out what we will do to know if we learned the words. Let's look back at the charts of our ideas for what it means to know a word and how we can show that we know a word. What can we do to find out how well we know the words after each session? [chart ideas]

- Together, we will co-construct a rubric or way of measuring how well one knows a word according to what we believe it means to know a word
  - Prompt students to reflect on their knowledge of words so they are able to recognize and identify other types of word knowledge in addition to knowing word definitions:
    - Sometimes you can use a word without being able to define it
    - Sometimes you feel like you know a word even if you don't know what it means
    - To really know a word well, you should be able to… (define it, use it, relate it to other things, make connections)
  - Use blank Word Knowledge Rating Guide to fill in, guide students towards fundamental feature of being able to *use* the word in the *context* of an authentic *activity* and seeing it's *connections* to other concepts
- Students work in groups on variables

Day 5: Finish Investigating Our Hypotheses

Goals: Complete detailed plan and how it will test our hypotheses

- Students will work together to complete their detailed plans and test our hypotheses steps

** Remind students to use advice and complete goals assessments **

Day 6: Data Collection Day 1

- Pretests, 30 minutes studying flash cards, posttests

Day 7: Data Collection Day 2

- Pretests, 30 minutes reading textbook with glossary, posttests

Day 8: Data Collection Day 3

Field trip: See if we can extend time for Web of Inquiry that day

- Pretests, 15 minutes in slough, 15 minutes in group project, posttests

Day 9: Record Data and Problems

Goals:

- Record data in organized way – have charts of tables and graphs (calculate class averages for each trial on word quizzes, how many students on KWG moved up by how many columns, how many stayed the same)
- Make graphs
- Record 'Our Data' and 'Problems' in Investigating Our Theories

Day 10: Analyzing Our Data

- Continue creating graphs, record data summaries, find patterns in data, report findings

Day 11: Finish Analyzing

Day 12: Synthesizing

Day 13: Extending Our Theories

Day 14: Posttests

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