SUPPORTING KNOWLEDGE BUILDING WITH INFORMATIONAL TEXTS DURING ELEMENTARY READING INSTRUCTION: A DESIGN BASED STUDY

By

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ABSTRACT OF THE DISSERTATION

Supporting Knowledge Building with Informational Texts

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This design study examined the problem of implementing knowledge building activities during elementary reading instruction. The study set out to determine how the classroom environment successfully supported students' collaborative knowledge building while working with informational text sources. In addition, it looked at how instructional scaffolds and artifacts developed for the classrooms being studied supported knowledge building with informational text sources. Finally, students' collaborative knowledge construction was examined in the context of Knowledge Forum® software. This study was conducted during two consecutive school years. Two classes of fifth graders, each with 23 students, participated in the research. Study 1 integrated teacher-led small group reading instruction with knowledge building. Students used Knowledge Forum and research guides to build knowledge from nonfiction text sources. Using design based research, the results of the first study were used to modify the procedure of the second study. Study 2 combined small group instruction, reading conferences, and student

reading partnerships with knowledge building activities. In this study, students had more opportunities to engage in face-to-face knowledge building discourse. In addition, they used Knowledge Forum, post-it notes, reading journals, and discussion boards to build knowledge from text sources. In both studies, students' knowledge building discourse was rated based on a tiered coding scheme of Knowledge Forum notes. The tiers attempted to rate how notes contributed to the advancement of community knowledge. In Study 2, small group reading sessions were analyzed using video data, and reading comprehension was assessed with running records and pre- and post-tests. Knowledge Forum discourse showed that children developed ideas and explanations based on nonfiction text sources during the second iteration. Video data of reading conferences also showed how the teacher scaffolded students' knowledge building. Comparison of reading levels and standardized test scores demonstrated how students in the knowledge building class advanced their independent reading levels at the same rate as those in non-knowledge building classes. The 23 fifth graders in Study 2 were able to build knowledge, improve reading comprehension, and discuss advanced science concepts when knowledge building was integrated with reading instruction.

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I am fortunate to have had the support of family as I worked toward this degree. I would like to dedicate this dissertation to my grandmother for her unwavering kindness, encouragement, and wisdom.

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CHAPTER 1: INTRODUCTION

When was space made someone please tell me and
i will respond to whoever answers my question.

-student's Knowledge Forum post

We live in a knowledge society. Last year, 304,912 new books were published in the United States alone (Dempsey & Bacon, 2014). Annual global Internet traffic is forecast to reach 1 trillion gigabytes, or 1 zettabyte, by 2015 (Xu, 2014). Children, as shown in the quote above, are naturally curious about their world. Teachers, however, may feel pressure to "cover" required material based on academic standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010; NGSS Lead States, 2013). Therefore, it is important to find ways to support children's authentic knowledge building activities in the context of existing school culture. In addition, children need to collaborate with each other to create new knowledge (Chan, 2012). Design research presents a promising method for studying instructional methods in classrooms. However, the products of design studies need to be practical and applicable in order to "scale up" to other schools and settings (Roshchelle, Tatar, & Kaput, 2008).

Knowledge building is a methodology in which a group works collaboratively to discuss and generate knowledge. To engage in knowledge building, individuals must interpret information and share ideas from authoritative text sources (Scardamalia & Bereiter, 2006). Children, however, face unique challenges in building knowledge from texts. First, they may need to comprehend above-grade-level sources during research

(Zhang, Scardamalia, Reeve, Lamon, & Messina, 2007; Zhang & Sun, 2011). Even diagrams and figures in informational text may present comprehension challenges (Slough, McTigue, Kim, & Jennings, 2010). Furthermore, instruction in nonfiction reading strategies is sometimes neglected in the elementary grades (Duke, 2004; Peacock & Weedon, 2002). Previous research focused on children's use of text sources during knowledge building (Zhang et al., 2007; Zhang & Sun, 2011), and partner-reading of challenging informational text (Sun, Zhang, & Scardamalia, 2010). This study built upon such research by integrating reading instruction and knowledge building based on sociocultural principles.

Sociocultural Principles

This dissertation study focused on designing instruction to scaffold children in building knowledge from informational text sources. Sociocultural methods such as collaborative learning (Bielaczyc, Kapur, & Collins, 2013; Chan, 2012), cognitive apprenticeships (Collins, Brown, & Holum, 1991; Collins, 2006), scaffolding (Pea, 2004; Reiser, 2004), and dialogic instruction (Lyle, 2008; Wells, 2000) formed the framework for the research design. Knowledge building is inherently sociocultural, in that a group works together to make sense of information and devise theories (Scardamalia, 2002). Similarly, best practices in reading instruction are also based on sociocultural frameworks. The design of the learning environment, and the development of a community of learners, is essential in reading instruction (Tracey & Morrow, 2012). To make sense of text, it is important for readers to discuss inferences and ideas with teachers and peers (Calkins, 2001; Fountas & Pinnell, 2006; Fountas & Pinnell, 1996). This dissertation research used design based methods, in which underlying theories

guided the engineering of a learning environment over multiple iterations (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003). In this way, sociocultural methods of reading instruction were integrated with knowledge building through design research.

Knowledge Building

Knowledge building is a pedagogical model that gives members of a group shared responsibility for creating knowledge. Developing and improving ideas based on information from authoritative sources is a central focus of knowledge building. Twelve principles guide the design of knowledge building environments, three of which were the focus of the current study. First, "knowledge building discourse" is the discussion of ideas, questions, and information within a knowledge building space. In this space, participants are able to advance ideas and knowledge collectively. Second, the principle of "constructive use of authoritative sources" includes the use of text resources to build new ideas. Third, "collective cognitive responsibility" calls for members of a knowledge building community to collaborate in developing theories and concepts (Hakkarainen, Paavola, Kangas, & Seitamaa-Hakkarainen, 2013; Scardamalia & Bereiter, 2006).

Knowledge Forum® (Scardamalia & Bereiter, 2008), used in this study, is a software tool developed to scaffold knowledge building discourse. Within Knowledge Forum, users can create "views" on various topics where they can post information as "notes". Notes can be linked to each other, as well as to images, files, and web pages. In this way, Knowledge Forum, formerly CSILE, provides a space where individuals can contribute ideas and theories based on knowledge from authoritative sources (Scardamalia & Bereiter, 1991).

Figure 1. Student referring to a text about The Big Bang during reading conference

The student quoted at the beginning of this chapter questioned the origins of our Universe. His post began the Knowledge Forum thread in Figure 2. Much of his group's knowledge of the Big Bang was based on the book pictured in Figure 1.

When was space made someone please tell me and i will respond to whoever answers my question.

Space was here since the begginning of time gut our Universe was only here for 14 billion years when the big bang happened and a fireball broke out with almost infinite temperature and density.

13-15 billion years ago. the universe started with a big bang which made earth. and earth kept expanding with all the helium and gas during the big bang. think of a balloon you put helium into it and it expands. ever since, the big bang is happening all the way in the part of space that is not discovered and is not covered in darkness and stars and planets. and ever since the universe keeps on expanding

i dissagree
the big bang had nothing to do with creating earth; earth was just dust that was so big it had gravity and pulled other objects in.

The big bang did not create or form the earth. the big bag was billons of years ago when a nother planet hit us and a piece came off of the earth and that was the moon and that is what the big bang was.

that is not what the big bang was the big bang could have formed from litterally nothing and it formed a fireball that had almost infinite density and temperature which exploded and formed our universe.

Figure 2. Knowledge Forum thread about The Big Bang

Reading Instruction

In this design study, use of Knowledge Forum was integrated with reading instruction. Rather than whole-class novels, best practices in reading instruction call for children to read books based on readiness levels and interest (Calkins, 2001). In a balanced literacy environment, sometimes referred to as Reading Workshop, teachers engage children in a cognitive apprenticeship during authentic reading activities. In this approach, peers discuss texts, students meet with teachers in conferences, and children are encouraged to make inferences about books. A wide variety of books should be accessible to all children, with instruction differentiated to the learner (Morrow, Wamsley, Duhammel, & Fittipaldi, 2002).This collaborative, cooperative method of reading instruction provides a means for children to co-construct meaning while discussing texts with teachers and peers (Calkins, 2001; Calkins, 2011; Cunningham & Allington, 1999; Fountas & Pinnell, 2006).

Small group instruction, in which a teacher scaffolds children's understanding of text, is based on principles of Social Constructivism (Tracey & Morrow, 2012). During such small group instruction, often referred to as guided reading, teachers scaffold children's comprehension of text within their zone of proximal development (Fountas & Pinnell, 1996). Similarly, in dialogic reading instruction, teachers engage students in authentic discourse about texts (Wilkinson & Son, 2011). Researchers have also used the dialogic approach to scaffold children's comprehension of science texts (Guthrie et al., 2004). Since knowledge building and reading instruction are both based on sociocultural principles, this design study attempted to integrate reading with knowledge building.

Research Questions

A sociocultural framework guided the design of the research questions examined in this study. Reading instruction was implemented along with collaborative knowledge building (Scardamalia & Bereiter, 2006), and pedagogical methods were developed during design research. The following research questions, examined during two successive iterations, drove the research design:

1. How do instructional design features of the reading classroom support students' collaborative knowledge building discourse?
2. How do instructional and distributed scaffolds support students' constructive use of authoritative sources during knowledge building?
3. How do students engage in knowledge building around informational text sources, in both face-to-face and online discourse? How do they participate in a learning community to collaboratively build knowledge?

Design Research

The Knowledge Forum thread in Figure 2 shows how students, along with instructional scaffolds developed in this design study, constructed knowledge using authoritative sources during reading. The classroom environment that resulted in such discourse was developed through design research, since it allowed for unanticipated variables in real educational settings to be taken into account (Barab, 2006; Cobb et al., 2003; Middleton, Gorard, Taylor, & Bannan-Ritland, 2008). In design research, instructional methods are modified and theories are advanced through successive

iterations. Rather than relying on efficient and familiar classroom pedagogy, sociocultural principles guided the design of instruction (Hong & Sullivan, 2009). Although it was based on principles, the first iteration of this study did not foster much idea generation during knowledge building. The instructional design was then modified, and students' resulting discourse was rich in ideas and theories based on texts. The results of the second iteration can be classified as "principled practical knowledge", or knowledge providing both explanation for outcomes and guidance to practitioners (Bereiter, 2014).

The dissertation chapters are organized around the development of this principled practical knowledge. First, in Chapter 2, existing principles from the literature will be examined. Next, Chapter 3 will illustrate how instruction was first applied, and then refined, based on an analysis of video data and Knowledge Forum discourse. The modified instructional design will then be described in Chapter 4. Following this, the results of Study 2 will show how knowledge building discourse was richer with the modified instructional design. Finally, the research questions will be revisited and discussed in Chapter 6. This study attempted to provide a model of knowledge building with text sources that is applicable to both teachers and researchers.

CHAPTER 2: LITERATURE REVIEW

In knowledge building, members of a group advance the leading edge of knowledge in their community. In order to advance knowledge, members of a community research and discuss ideas collaboratively (Chan, 2012). Knowledge building is based on principles (Scardamalia, 2002) rather than pedagogical procedures (Hong & Sullivan, 2009; Zhang, Hong, Scardamalia, Teo, & Morley, 2011). Scientists, engineers, and other professionals form knowledge building organizations to advance the leading edge of knowledge within their disciplines. Schools can prepare children by fostering active participation within collaborative learning communities. In order to create classroom knowledge building communities, classroom discourse must provide a voice to all learners. New technologies, such as Knowledge Forum, support such knowledge building discourse. Dialogic and sociocultural instructional methods also foster collaborative learning. For this reason, these models were reviewed when constructing the design study outlined in this dissertation.

Instructional methods in literacy are built around sociocultural frameworks. For example, teachers scaffold children in applying reading strategies and comprehending text (Calkins, 2001; Fountas & Pinnell, 2006; Tracey & Morrow, 2012; Wilkinson & Son, 2011). In this study, knowledge building was integrated with reading instruction through design research methods over two iterations (Cobb et al., 2003). Scaffolding (Pea, 2004) and cognitive apprenticeships (Collins, 2006) were used during small group reading conferences. Knowledge building is also based on sociocultural principles, in which a community of learners works to build knowledge as a group (Bielaczyc et al.,

2013; Scardamalia & Bereiter, 2006). Therefore, sociocultural theories formed the overarching framework for integrating knowledge building with reading instruction.

Sociocultural Frameworks

In this study's instructional design, students read and shared ideas about informational texts during knowledge building activities. Small group instruction was dialogic (Mercer, Dawes, & Staarman, 2009; Wilkinson & Son, 2011), and it also focused on scaffolding children within their zone of proximal development (John-Steiner & Mahn, 1996). In designing instruction, multiple levels of the school environment were also taken into account (Bronfenbrenner, 1977). First, the instruction had to meet the needs of Common Core Standards in reading. In the fifth grade, approximately half of the reading standards are based on nonfiction text (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). Next, the instructional design, curriculum, and pacing needed to fit in with the school's use of Reading Workshop. Specifically, it aligned with the nonfiction reading unit (Calkins, 2011) based on the districtwide curricular plan. During the study, the teacher scaffolded students' knowledge building with texts sources in a cognitive apprenticeship (Rogoff, 1990). Developing a community of learners is also essential in knowledge building, requiring collective responsibility to generate new knowledge.

Community of Learners in Knowledge Building

A community of learners forms a different social structure than the traditional classroom, in which the teacher directs the discourse of the class (Bielaczyc et al., 2013). Instead, within a knowledge building community, all members are engaged in authentic knowledge work. Rather than completing worksheets or assigned tasks, the children's

purpose is to share knowledge with other members of the community. Activities and worksheets thus become scaffolds in supporting children to build and share knowledge. In knowledge building organizations, concepts are not limited to the individual. Instead, concepts can range along a continuum from individual to collective. Members of a group can form concepts collaboratively as part of a larger community (Engeström, 2013). In knowledge building, the teacher and students must work together to create a community of learners (Scardamalia & Bereiter, 2006; Zhang & Sun, 2011). Dialogue between individuals plays a large role in fostering a learning community. Rather than directing discourse, the teacher can assume the role of a facilitator of dialogue. This dialogic instruction serves as a model for children in talking about knowledge and ideas.

Dialogic Instruction

In a community of learners, the teacher and students use authentic dialogue, rather than Initiation-Response-Feedback (IRF) discourse in which the teacher leads the discussion and asks questions (Lyle, 2008). For example, the teacher often acts as a partner in dialogic classrooms, discussing ideas with students (Tabak & Baumgartner, 2004). Talk is natural and authentic between peers, as well as between students and the teacher. The teacher does not engage in authoritative discourse, or "lecturing", in which the correct knowledge is told to students. Furthermore, dialogic approaches to reading comprehension provide a means for children to co-construct meaning while discussing texts (Wilkinson & Son, 2011).

In a dialogic classroom, children have to learn social norms like listening actively and responding. Dialogic classrooms are even helpful for promoting scientific discourse (Dawes, Dore, Loxley, & Nicholls, 2010). In addition, discourse in science shares

features with knowledge building, in that knowledge grows progressively as members of a group contribute more information to develop new ideas (Bereiter, 1994). Dialogic instruction is an important sociocultural feature of knowledge building classrooms, in which members of the knowledge building community, including the teacher, discuss ideas and theories. In addition to authentic dialogue, teachers also play a role in scaffolding students' learning through discourse.

Scaffolding

In a collaborative environment, scaffolding allows children to engage in authentic knowledge work using legitimate peripheral participation (Collins, 2006). With scaffolding, children are able to advance skills over time by working within their zone of proximal development (Rogoff, 1990). The zone of proximal development is what people are capable of with guidance from a more able adult or peer. Also, Vygotsky posited that psychology moves from external to internal – that dialogue between children and adults becomes internalized by the child as independent thought (Vygotsky, 1997). For this reason, scaffolding between teacher and student first takes place in the physical world, in discourse, before it can be internalized and acted upon independently. However, there is a difference between informal scaffolding and the formal scaffolds developed in schooling. Scaffolding occurs frequently in informal, non-school situations, and is a natural way that humans learn from others. Children are able to participate in a community of learners through scaffolding in a school setting, since scaffolding can help children to accomplish tasks that are too difficult for them to do independently. Even posters and other classroom tools and artifacts can be used as scaffolds (Collins et al., 1991).

In scaffolding, the learner's zone of proximal development is assessed to provide necessary support. As the learner becomes more confident, scaffolding is faded. Students can work along with adult support as scaffolding is slowly removed. In this way, children are able to work on more challenging tasks than they would be capable of independently (Reiser, 2004). Structuring and problematizing are both important to consider when designing scaffolds. For example, scaffolds can focus (reduce complexity), model, and channel an activity or task. Furthermore, all higher mental functions are a copy of social interactions, so that children will later internalize scaffolding discourse (Pea, 2004).

Software tools can serve as scaffolds as well. As scaffolding became more advanced, some researchers point out that important diagnostic features of scaffolding, such as assessing learning and fading support, have been neglected with the use of software technologies that provide scaffolding to students while learning (Puntambekar & Hubscher, 2005). Scaffolding needs to support students toward meeting target performance (Sherin, Reiser, & Edelson, 2004), and should be tailored to the individual learner in developing knowledge and skills. In designing scaffolds, it is important to create problems for students to solve, and also to provide structure to tasks, which is often accomplished through the use of software tools and other scaffolding artifacts (Reiser, 2004). This serves to further constrain complex knowledge work, so that it is accessible to learners as they develop necessary knowledge and skills.

The role of the teacher is also important. In scaffolding, a child works with a more competent and knowledgeable teacher or peer in their zone of proximal development (Gallimore & Tharp, 1990). Often, the teacher serves as a partner in the complex knowledge work that is done between teacher and student (Tabak & Baumgartner, 2004).

In the "teacher as partner" model, the teacher and student have authentic dialogue about knowledge, instead of the teacher providing authoritative information for the student to internalize. In designing scaffolding, it is important to look at 1) how to assess and support the learning, 2) how to work as a partner with the learner, and 3) how to provide artifacts that make knowledge work concrete. With the aid of scaffolds, children are able to engage in complex cognitive tasks. For this reason, scaffolds may be employed within the cognitive apprenticeship model.

Cognitive Apprenticeships

Teachers often scaffold students in a cognitive apprenticeship, or a method of learning complex skills that deal with knowledge and symbolic representations. Unlike a traditional apprenticeship where learners work with concrete objects, learners in a cognitive apprenticeship work with skills and ideas. Because of this, the skills and ideas must be made concrete so that learners can cognitively act upon them (Collins et al., 1991; Collins, 2006). An example of apprenticeship in reading is reciprocal teaching, in which students took more and more responsibility for their own learning after modeling the strategies used by the teacher (Palinscar & Brown, 1984). Reciprocal teaching was found to be very effective. Students were supported in applying reading strategies, and the strategies were gradually faded as children internalize reading skills. Sociocultural principles, which drove the design of a cognitive apprenticeship, also provide a framework for knowledge building communities.

Knowledge Building

Knowledge building is a model in which students and teachers advance the knowledge base of a community. It is not important if every person understands all

knowledge, but rather that the knowledge of the whole group moves forward. In knowledge building, students assume epistemic agency, researching and advancing knowledge on their own. The teacher serves as a guide rather than as a purveyor of information. Individuals work together to create a shared community of knowledge (Scardamalia & Bereiter, 1991; Scardamalia & Bereiter, 2006). The knowledge building methodology is based on principles rather than pedagogy, causing some variation in its classroom implementation (Hong & Sullivan, 2009; Zhang et al., 2011).

Knowledge Building Principles

The principles of knowledge building were used to frame this design study. Specifically, the knowledge building principle of "authentic use of authoritative sources" was viewed through a dialogic model of reading instruction. Knowledge building is a methodology in which a group works together to advance the state of knowledge within their community. In knowledge building, it is not necessary for children to discover previously unknown information; rather, they collaborate in the process of creating knowledge that is new to their community. In addition, the knowledge building model was purposely based on principles. This was so that teachers did not follow a scripted format without understanding the underlying concepts behind children's knowledge building research. Three principles are especially relevant to this study: constructive use of authoritative sources, collective cognitive responsibility, and knowledge building discourse (Scardamalia, 2002; Scardamalia & Bereiter, 2006).

In knowledge building, in addition to real-world observation and hands-on experimentation, children use texts as authoritative sources to discover new knowledge. Therefore, one principle is "authentic use of authoritative sources". This is relevant to the

current study, which focused primarily on children's use of text sources during knowledge building activities. The second principle that will be examined is "knowledge building discourse", which is essential for developing a knowledge building community. Through knowledge building discourse, both online and offline, children can collaborate in order to weave the information from texts into their own community knowledge. Finally, children must have motivation to research collaboratively, which is included in the principle of "collective cognitive responsibility". Each of these knowledge building principles will be discussed in the following sections.

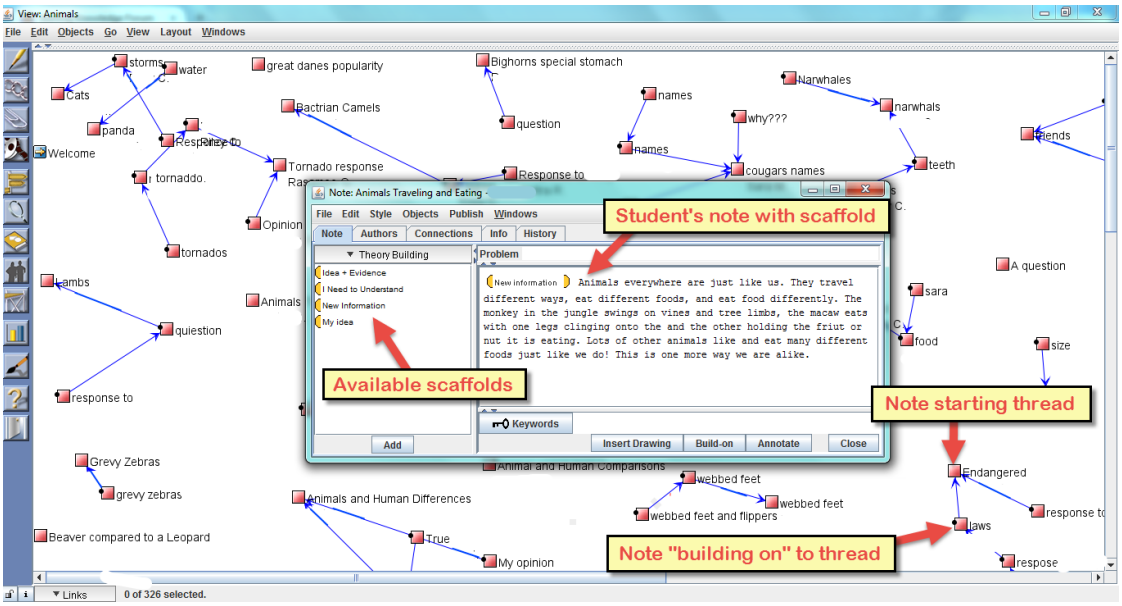


Figure 3. Knowledge Forum database

Knowledge Forum. Knowledge Forum is an asynchronous discussion tool, meaning that children can log in at different times to add to the group's discussion (Scardamalia & Bereiter, 2006). The purpose of the tool is to facilitate knowledge building discourse. Rather than all discourse being directed by the teacher, Knowledge Forum allows children and adults equal participation in discussing information, theories,

and ideas. A number of features within Knowledge Forum support students' knowledge building discourse. Scaffolds, such as "new information" and "I need to understand", are embedded to help students when posting. Also, members can "build on" to other's ideas by responding to others' notes. In addition, it is possible to "rise above" previous ideas by synthesizing a number of notes with an underlying concept by using the rise above function. Figure 3 shows the Knowledge Forum database, including students' notes within the knowledge building view. The screenshot in Figure 3 is of the "Animals" view, with one note, "Animals Traveling and Eating", clicked open for viewing. In addition, from the "Welcome" screen, children had access to "Chemistry", "Planets", "Food Chains", and "History" views. By using Knowledge Forum, members of a knowledge building community can participate actively in a learning community to collaboratively create and improve ideas over time (Chan, 2012).

Constructive use of authoritative sources. For both children and for practicing scientists, much knowledge needs to be gleaned from books and other text sources. To engage in the work of scientists, children also need to read information related to their experiments (Metz, 2008). Students are also able to use Knowledge Forum to develop ideas from authoritative sources. Many studies have shown that children use authoritative text sources during knowledge building activities (Hakkarainen, 2004; Zhang et al., 2007; Zhang, Scardamalia, Reeve, & Messina, 2009; Zhang & Sun, 2011). These sources may include books, articles, and even expert information from teachers and researchers.

Knowledge building with texts has been successfully applied in the classroom. When using nonfiction texts in knowledge building, students can form and reform groups based on research questions and interests. Using grounded theory, a qualitative study

described four frameworks for viewing reading during knowledge building: as advancement of community knowledge, as progressive problem-solving, as embedded in the knowledge building discourse, and as a dialogue between local understanding and knowledge in the world (Zhang & Sun, 2011). In another study, the teacher offered strategies for supporting children in finding appropriate texts for their research. This teacher, described as being particularly adept at fostering knowledge building, required students to write down research questions before going to the school library for books. Even so, his students had difficulty finding books about gravity that they could understand (Hakkarainen, 2004). In yet another study, first graders read newspaper articles, books, and World Wildlife Fund publications during their research on pollution (Scardamalia & Bereiter, 2006).

One study analyzed how students went beyond authoritative texts, or developed new ideas based on research. During a fourth grade unit on optics, students produced 287 notes in Knowledge Forum. Of these, 40 notes introduced resources; 26 of those notes went beyond the resource to draw conclusions from, or constructively use, the sources (Zhang et al., 2007). Roughly one tenth of the Knowledge Forum notes consisted of constructive use of authoritative sources. When studying optics, students also read text sources collaboratively to aid in comprehension. Students were able to formulate theories and develop scientific explanations based on text sources (Zhang & Sun, 2011). In many studies, online Knowledge Forum notes were coded and analyzed to determine the quality of students' knowledge building discourse (Sun et al., 2010; Zhang et al., 2007; Zhang & Sun, 2011). Discourse, both online and offline, is essential to aid children in making sense of text sources (Scardamalia, 2002).

Knowledge building discourse. Discourse allows members of a collaborative knowledge building community to share ideas, theories, insights, and information. Practicing adult scientists advance knowledge through discourse (Bereiter, 1994). Similarly, science should be presented to children as a way to progressively improve ideas (Bereiter, Scardamalia, Cassells, & Hewitt, 1997). In addition to hands-on activities, science includes both explanation and discussion (Bereiter & Scardamalia, 2009). For example, as knowledge building progresses over time, students' discourse becomes richer with scientific explanations (Hakkarainen, 2003). Activity Theory demonstrates that the purpose of a knowledge building classroom is knowledge building discourse, as opposed to assigned tasks in a traditional classroom (Hewitt, 2004). Discourse among peers is important a knowledge building classroom, because it allows children to refine and develop ideas collaboratively (Golbeck & El-Moslimany, 2013).

Students have been shown to generate advanced knowledge building discourse. To analyze such discourse, researchers developed Knowledge Building Discourse Explorer, a method of analyzing discourse that shows how individuals contribute to the knowledge of the group (Oshima, Oshima, & Matsuzawa, 2012). As knowledge building progresses over time, students also use more scientifically advanced vocabulary, which is also correlated with their understanding (Sun et al., 2010). Furthermore, students who are new to knowledge building can improve their discourse by collaborating with more experienced peers. One class of fifth graders' Knowledge Forum notes changed from information-centered to explanation-centered after collaborating with a more experienced fifth grade class (Lai & Law, 2006). Through knowledge building discourse, fourth

graders were also able to develop scientific explanations for ideas (Hakkarainen, 2004). In order to analyze discourse, researchers can use mixed methods to both analyze discourse with codes, and view discourse qualitatively in larger chunks (Hmelo-Silver, 2003).

Teachers also play a role in knowledge building discourse. Although the designers of Knowledge Forum place an emphasis on overarching principles instead of defined pedagogy, researchers acknowledge that some teachers are exceptionally skilled at using Knowledge Forum in the classroom. With an experienced teacher of Knowledge Forum, groups often formed and reformed based on students' interests in a topic (Hewitt, 2004). Immediately following a whole class discussion to introduce a unit, students often formed into small research groups. After an initial introduction, one teacher laid out questions for students to begin researching. Small groups formed based on these teacher initiated questions (Hakkarainen, 2004). In sustaining knowledge building discourse, all members of the group must take responsibility for contributing knowledge and ideas.

Collective cognitive responsibility. In addition to using sources constructively, members of a knowledge building community also need to work together and sustain discourse in order to advance knowledge. Knowledge building occurs within a group, rather than at the level of the individual. Unlike in a traditional classroom, where students look to the teacher for authority, in knowledge building, they all assume responsibility for creating ideas and finding new information. To have cognitive responsibility, one has to think and take responsibility for ideas and concepts, rather than completing assigned tasks. Students take responsibility for "goal-setting, planning, and monitoring" in their learning (Scardamalia, 2002). In one classroom, group design evolved from fixed small

groups, to interacting groups, to flexible student-created groups over the course of three years (Zhang et al., 2009).

In addition, it is necessary to transform the traditional classroom structure in order to create a knowledge building community (Hakkarainen, 2009). Technologies such as Knowledge Forum are one way to change social practices. In addition, knowledge building principles need to be integrated with knowledge building culture of the school. One study worked to create a knowledge building culture even before introducing Knowledge Forum (So, Seah, & Toh-Heng, 2010). In an environment that supports knowledge building, children are able to engage in collective responsibility for advancing knowledge (Bereiter, 1994; Bereiter et al., 1997; Hakkarainen, 2003; Metz, 2008).

Practical Application of Knowledge Building

Researchers who study knowledge building have proclaimed that its widespread implementation in the classroom is difficult. One reason is that knowledge building is purposely based on principles. It is necessary to use principled, practical knowledge to apply designs such as knowledge building in the classroom (Bereiter, 2014). Some assume that knowledge building is only for high achieving students; however, one study with 112 third grade students in Singapore showed that it benefited all learners. The study also found that lower level learners found it difficult to apply knowledge building strategies, and were in need of more scaffolding (So et al., 2010). Debate exists in the literature as to the practical ways to implement knowledge building in real world settings. A national case study in Finland also looked at the design of knowledge building in the classroom, and how teachers implemented pedagogy. The shift from individual to collaborative work was difficult for students and teachers (Lakkala, Lallimo, &

Hakkarainen, 2005). In creating a knowledge building classroom, it is necessary to transform the social dynamics of the classroom (Hakkarainen, 2009). A large portion of knowledge building studies took place at laboratory schools (Oshima et al., 2006; Sun et al., 2010; Zhang et al., 2009; Zhang, Hong, Teo, Scardamalia, & Morley, 2008). This may be due to the fact that teachers often prefer efficiency-oriented (or practical) instruction to innovation-oriented instruction (Hong & Sullivan, 2009). The current dissertation study, by integrating knowledge building with sociocultural reading methods, created innovation-oriented instruction that is practical to implement in the classroom.

Sociocultural Approaches to Reading Instruction

In a reading classroom, learners have to construct meaning based on their prior knowledge within a social environment. Readers interact with the text, with the available books and artifacts, and with each other as they interpret and discuss texts. The classroom should have a wide variety of books for children to choose from, as well as the opportunity to talk with others about ideas based on books (Calkins, 2001; Fountas & Pinnell, 2006; Morrow et al., 2002). In the current study, both whole class and small group methods of reading instruction were integrated with knowledge building activities.

Small Group Reading Instruction

Reading methods have been developed that help the teacher scaffold students within their zone of proximal development. It is based on Social Constructivism, a method in which the teacher helps children to learn and apply reading strategies within their zone of proximal development (Tracey & Morrow, 2012). Small group scaffolding with texts, often referred to as guided reading, is a sociocultural method in which the teacher forms a cognitive apprenticeship in reading with students.

Guided reading provides scaffolding at a student's instructional level. With teacher scaffolding, students are able to comprehend higher levels of text than they could independently. In a small group lesson, the teacher might introduce a text, explain text features, and lead a discussion about the text when students have finished reading. In guided reading, the teacher selects books for students based on students' reading levels and interests (Fountas & Pinnell, 2012). In addition, teachers can support children in applying appropriate strategies to texts, including "thinking about the text", "thinking within the text", and "thinking beyond the text". The teacher assumes a large portion of the responsibility for choosing the text and leading the discussion.

During small group reading instruction, it is possible for teacher talk to be more didactic rather than dialogic in co-constructing meaning about text. One study looked specifically at the discourse between teachers and students during guided reading, by recording six guided reading sessions in each of four schools in England. Each session contained the same six 10 – 11 year-olds working with their teacher (Skidmore, Perez-Parent, & Arnfield, 2003). They found that the majority of teachers' instruction sessions were authoritarian, rather than dialogic. The teacher led the discussion, asked questions with known answers, and called on students to respond. Guided reading is useful for helping students learn strategies within their zone of proximal development. However, it is important for teachers to allow students the opportunity to express their ideas about texts during small group discussions. Small group instruction is one component of a balanced literacy environment (Cunningham & Allington, 1999; Fountas & Pinnell, 2006).

Reading Workshop

In addition to small group instruction, the reading classroom is often organized to include student-teacher conferences and independent reading. This instructional method, often referred to as a reading workshop, is an approach that provides children time to engage in authentic reading experiences (Calkins, 2001; Calkins, 2011; Fountas & Pinnell, 2006). In addition to independent reading, children meet with the teacher individually and in small groups in cognitive apprenticeships (Collins, 2006). During this time, children confer with a teacher to learn expert reading skills. As in other cognitive apprenticeships, children use mediating tools and artifact to make thinking visible (Calkins, 2001; Calkins, 2011).

The Reading Workshop approach incorporates a number of physical tools to support children's thinking about text. Since children cannot usually write directly in texts, they often use post-its to record their thinking (Calkins, 2001). Also, children use journals to write ideas about texts (Calkins, 2001; Fountas & Pinnell, 2006). The journals provide an open-ended knowledge building space for a children's own thoughts about their book. Finally, in authentic reading instruction, children self-select books based on their interest and reading level. This choice shares features with knowledge building, where children choose topics to find information to share with their group.

Discourse during reading instruction also supports building knowledge and generating ideas from text sources. First, teachers scaffold students in talking about books with others (Calkins, 2011). Throughout the year, children are encouraged to "talk long" about their books, including their own ideas based on evidence. Generating ideas based on evidence, or "authentic use of authoritative sources", is also a principle of knowledge

building. Finally, teachers are further able to scaffold individual students with reading conferences. In the present study, the reading conferences were focused mainly on scaffolding two areas of students' skills: knowledge building discourse and comprehending / rising above text sources. It is important not to use I-R-F dialog when conferring with students; instead, it should be dialogic in nature (Porath, 2014).

For these reasons, the instructional models often referred to as guided reading and reading workshop were used to support knowledge building activities during a nonfiction unit in the present study. The integration of Knowledge Forum software provided a virtual space for children to build knowledge during reading instruction.

Dialogic Instruction

A similar approach to reading instruction, the dialogic approach, offers a flexible space for readers to co-construct meaning through dialogue (Wilkinson & Son, 2011). For this reason, it also aligns with the knowledge building methodology. In the dialogic approach to reading, rather than learning discrete reading strategies, individuals engage in discussion about a text. The discussion around a text is heavily dependent on content. For this reason, the approach is specifically suited to nonfiction text and knowledge building. For example, Concept-Oriented Reading Instruction developed goals for content learning, increased student motivation to read, and improved reading comprehension (Guthrie et al., 2004). Another program, In-Depth Expanded Applications of Science, or IDEAS, integrated language arts with nonfiction science texts. The program improved science content knowledge and reading comprehension (Romance & Vitale, 2001). These dialogic approaches were heavily dependent on discussion of science content in nonfiction texts.

Dialogic scaffolds were developed by researchers during dialogic instruction in science (Dawes et al., 2010). For example, a sample lesson would have children begin with exploratory talk about a text. This would include making predictions, previewing the text, and brainstorming questions. In this part of small group instruction, the teacher would model how to listen and accept others' ideas. Next, children would take turns reading a paragraph and captions, either aloud or silently. The teacher would have "talking points" prepared based on the content of the text. These would include topics that add to group knowledge or conflict with students' concepts. Finally, the teacher and students would discuss and explain the concepts from the text. If applicable, the teacher could show students a physical model outlining the concept. Since this study engaged children in reading nonfiction, it is also important to look at children's comprehension of informational text sources.

Comprehension of Informational Texts

Specifically, children often work with science texts in building knowledge. However, science texts can be difficult to comprehend. Studying science with trade books may be beneficial for children. One study found trade books to be of better quality than science textbooks (Smolkin, McTigue, Donovan, & Coleman, 2009). The authors analyzed 43 trade books and found roughly one quarter of the clauses in the books to be explanatory in nature. However, the trade books were not compared to textbooks; instead, they were assumed to contain more explanatory causes than textbooks. In contrast, a similar study examined 76 science trade books for children age 7 through 11. This research did not find a high level of explanation in science trade books (Newton, Newton, Blake, & Brown, 2002). It appears that explanation in books is variable, so they would

have to be selected accordingly.

Whether or not nonfiction sources contain explanatory text, it may be important for children to be exposed to such sources. In the knowledge building, students should use nonfiction texts for authentic purposes. When using nonfiction, educators should explicitly teach nonfiction comprehension strategies and the difference between fiction and nonfiction texts (Duke, 2004). In another study, 180 third, fourth, and fifth graders were explicitly taught the nonfiction strategy of searching for information in text. Fourth and fifth graders were able to comprehend nonfiction text better when they were taught both strategies and self-monitoring techniques (Symons, MacLatchy-Gaudet, Stone, & Reynolds, 2001).

In knowledge building, children frequently work with informational text in finding and interpreting new information. When offered adequate teacher scaffolding, it is even beneficial for children to work with challenging informational texts above their reading instructional level (Fisher & Frey, 2014). Although a number of different methods have been developed for teaching nonfiction, they all rely on teacher scaffolds for supporting students' thinking about texts. In applying knowledge building, it is important for teachers to choose a method that fits in with the culture of their school. This dissertation research integrated the reading workshop model with knowledge building.

Design Research

Design research provides a framework for testing educational technology and innovations within real settings and classrooms. In design research, educational tools and instructional techniques can be modified based on observations in the field. In design research, different methodologies can be used to answer a research question during

successive iterations. Design researchers, therefore, develop new theories based on the observations drawn from implementing a newly designed method (Cobb et al., 2003).

Design studies can be complex, can have many variables, and are often written as narratives (Shavelson, Phillips, Towne, & Feuer, 2003). For this reason, some researchers doubt whether the claims in design research can be supported. However, by using different research methodologies in different iterations of design research, various aspects of research questions can be supported. In this way, an intervention can be "scaled up" to other settings (Tatar et al., 2008). Design research, more so than laboratory research, may show how interventions work within a realistic school setting. For this reason, design research is useful in knowledge building studies, providing an overall view of a classroom learning community. It is also flexible enough to allow researchers to change methods during the intervention (Barab & Squire, 2004).

Unlike action research, design research is based on underlying research principles. Conjecture mapping shows how principles lead to design of a learning environment (Sandoval, 2014). Design research works by applying the intervention in real-world contexts. In that way, one can test unintended variables and effects (Bielaczyc, 2013). Through design research, "principled practical knowledge" is created. This is knowledge that is useful to practitioners, yet also helps explain phenomena to researchers. One example mentioned was the Wright brothers, who tested flight in real-world context and designed planes based on scientific principles (Bereiter, 2014).

Design research is a framework that helps to look at the extensive variables found in classrooms (Barab & Squire, 2004). This method offers a unique way to both develop and test instructional interventions in real-world contexts. In order to avoid trial-and-error

designing of instruction, any design study must be based on theoretical principles (Collins, Joseph, & Bielaczyc, 2004). The principles framing this dissertation study were based on knowledge building and dialogic approaches to reading instruction. By applying these principles, a method for children to share research during knowledge building was improved through two iterations.

Purpose of the Study

One principle of knowledge building is "authentic use of authoritative sources" (Scardamalia, 2002). This states that children should be able to find, use, interpret, analyze, and build onto existing knowledge found in scientific text. However, children face challenges in using authoritative sources constructively. First, it may be difficult for them to comprehend nonfiction text. Many knowledge building studies, however, assume that children can search for and comprehend nonfiction sources of information. Therefore, this design study used a dialogic approach to reading instruction to support children in building knowledge from authoritative sources.

By moving from books, to post-its, to Knowledge Forum notes, this dissertation attempted to answer three research questions. First, how do instructional design features of the reading classroom support students' collaborative knowledge building discourse? Second, how do instructional and distributed scaffolds support students' constructive use of authoritative sources during knowledge building? Finally, how do students engage in knowledge building around informational text sources, in both face-to-face and online discourse? The overarching framework for the study was built on sociocultural principles, in which a cognitive apprenticeship was embedded within dialogic methods of reading instruction. Chapter 3 will show how principles drove the instructional design of Study 1.

CHAPTER 3: STUDY 1

Framework and Methods of Study 1

As stated previously in Chapters 1 and 2, sociocultural principles guided the design of the learning environment. The reasons for this were twofold. First, knowledge building is based on sociocultural theory, in which a community of learners advances the knowledge of a group (Scardamalia & Bereiter, 2006). Second, reading instruction is also based on sociocultural principles, in which members of a classroom community collaborate to make sense of texts. The knowledge building model is based on principles rather than pedagogy (Hakkarainen, 2009). The first iteration, therefore, used these sociocultural principles to design pedagogy to support children's knowledge building around text sources. This study designed scaffolds for children's knowledge building through a cognitive apprenticeship in reading instruction. The cognitive apprenticeship was meant to launch children into higher levels of knowledge building discourse. This discourse, built around new information from authoritative text sources, occurred during small group instruction.

This chapter will discuss the Methods and Results of the first iteration. An overview of the first iteration is illustrated in the conjecture map in Figure 4. A conjecture map is a graphic organizer used to frame the implementation of and changes to a design based study. The conjecture map is based on a design research model (Sandoval, 2014), and outlines the embodiments used in the first iteration. The research questions drove the design of instruction, the development of scaffolds, and the analysis of knowledge building discourse.

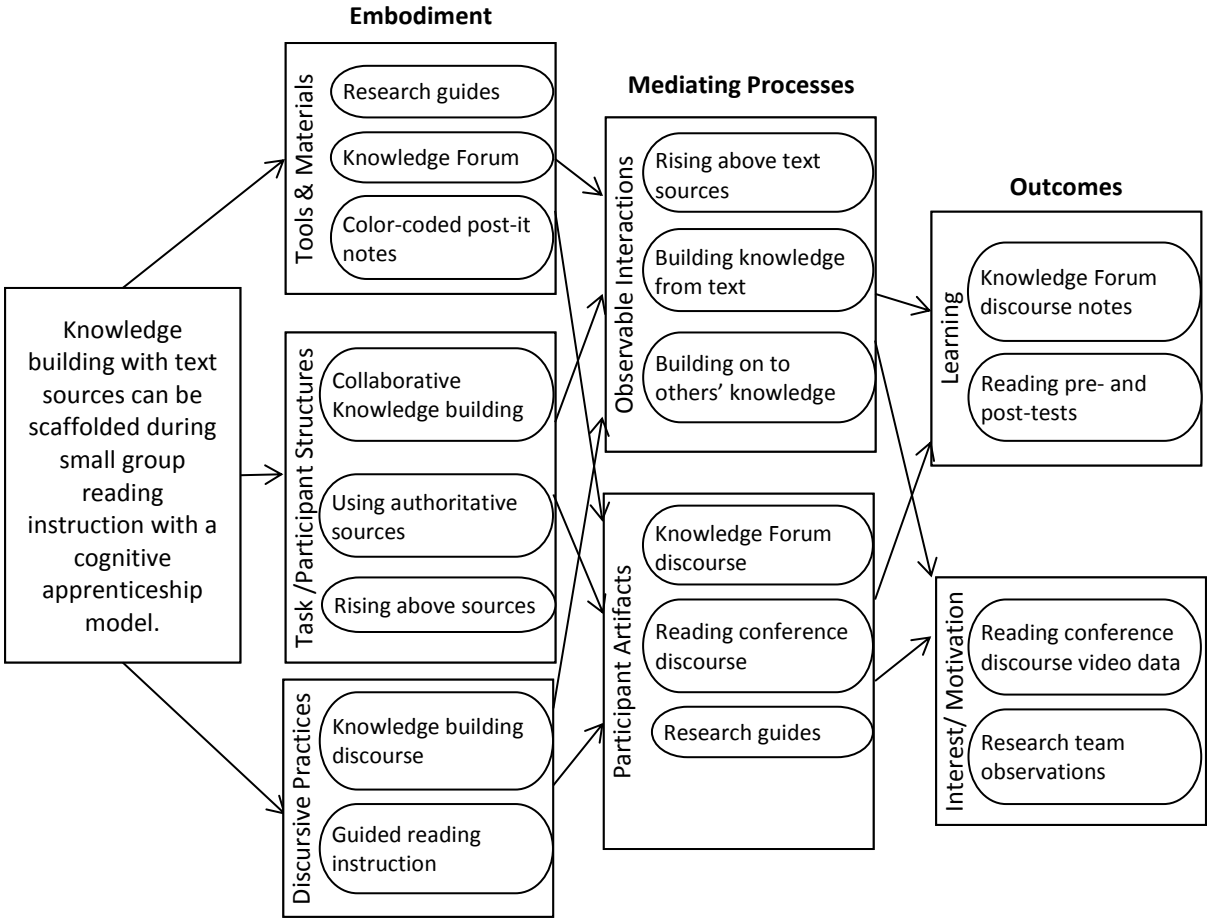


Figure 4. Conjecture map for Study 1

A number of factors were examined when refining the cognitive apprenticeship developed after a review of the literature. First, video data showed how students engaged in knowledge building activities during small group instruction. Next, knowledge building discourse within Knowledge Forum was coded and analyzed. Also, a research journal highlighted issues with student motivation and instructional materials. Finally, results of reading comprehension tests were analyzed. The remainder of this chapter will outline the methods and results of the first iteration. Later, in Chapter 4, the ways in which these suggested changes to the second iteration will be analyzed.

Table 1. Principles driving study 1

Sociocultural Theory	Tools & Materials	Participant Structures
Cognitive apprenticeship		
Method		
Modeling	Use of small post-its to record information	Teacher introduces and models skills in small group reading instruction
Scaffolding	Knowledge Forum online scaffolds Use of Research Guides to organize information	Modeling and practice during small group reading instruction
Sequencing		
Increasing complexity	Beginning with unlimited text sources	No change throughout iteration
Sociology		
Community of learners	Knowledge Forum	Student research teams
Knowledge building		
Knowledge building discourse	Posting notes within Knowledge Forum	Discussing shared text during teacher-led small group reading instruction
Constructive use of authoritative sources	Students read same teacher-chosen book during reading groups	Students choose from Internet research and library books

Sociocultural Design Principles

A cognitive apprenticeship model helped children engage in knowledge building discourse. When using authoritative sources constructively, children had to think about

textual information, rise above the text sources, and share new knowledge with a group. This study examined the ways in which a teacher supported children's use of authoritative sources, thus gradually fading the scaffolds as children assumed more responsibility for knowledge building. The conjecture map in Figure 4 represents how the instructional design and materials supported sociocultural principles in the first iteration, or Study 1, as outlined in this chapter.

Cognitive apprenticeship. A community of learners was fostered within the learning environment. The class was separated into four research teams (Inner Planets, Outer Planets, Black Holes/Dark Matter, and Stars/Galaxies). Teams were free to post to each other's views within Knowledge Forum. When researching, however, students primarily chose to focus on their own team's topic. Teacher-guided knowledge building discourse took place during small group reading sessions. These discussions were based on shared nonfiction texts chosen by the teacher. During the course of the study, children practiced face-to-face knowledge building during a cognitive apprenticeship. During this time, the teacher met with one research team and modeled a skill using a teacher-selected text. Next, students practiced the skill along with support from the teacher. The details of this small group instruction will be outlined later in this chapter. Students engaged in independent knowledge building discourse using Knowledge Forum.

Knowledge Building Design Principle

Students became a community of learners by applying knowledge building principles. The goal of the study was for children to develop their own discourse around informational texts. For this reason, knowledge building principles also drove development of the instructional design (Scardamalia, 2002). Based on the principles of

"constructive use of authoritative sources", children used books to find new information and create new ideas. "Knowledge building discourse" was the driving principle behind reading instruction and use of Knowledge Forum software. Finally, the knowledge building principle of "collective responsibility" drove the formation of research teams. As represented in the conjecture map in Figure 4, knowledge building was combined with a cognitive apprenticeship during reading instruction to support children's use of text sources.

Procedure

Participants and setting. The first iteration took place in a public elementary school in NJ. The district was rated as District Factor Group I. In the school, 10.3% of students had IEPs. The student mobility rate for 2009 – 2010 was 1.9%. Based on the 2012-2013 School Performance Report, the school placed in the 79th percentile among its peer group, and the 95th percentile statewide, for academic achievement. Also, English was spoken as a first language at home by 93.7% of the students. The total school enrollment for 2011-2012 was 638 students. The participants during the first iteration were my class of 23 fifth graders. The students were either 10 or 11 years old at the time of the intervention.

Instructional design features (research question 1). The learning environment was designed to support knowledge building discourse. Features of the classroom environment fostered constructive use of authoritative text sources. Each day for 6 weeks, children participated in 60 minutes of reading instruction. First, the teacher introduced a strategy with a minilesson. Next, the teacher met with a research team in a small group for 30-40 minutes. During this time, another research group of 4-5 students posted on

Knowledge Forum. The rest of the students read their own research books and took notes on color-coded post-its. They then organized their notes into research guides held in folders. This procedure will be described in more detail in the following sections.

Reading instructional methods. To foster knowledge building discourse, dialogic instruction was employed during small group reading sessions. First, students were introduced to a shared text. Next, they read the text and marked their thinking and ideas on post-its. Finally, the group engaged in knowledge building discourse, with the teacher guiding the discussion. A small orange cone (seen in Figure 9 on page 48) was used for turn-taking during discussions, and students were encouraged to answer each other before contributing new ideas. During small group instruction, students wrote "stop and think" post-its to rise above authoritative sources based on evidence from the text. The teacher also reviewed nonfiction text features, such as captions and subtitles. Similar to reciprocal teaching (Palinscar & Brown, 1984), students practiced a skill modeled by the teacher – for example, finding new information or making an inference – by recording ideas on post-its. At the end of a session, students passed around their books and "built on" to others' ideas by writing new post-its. The weekly small group reading schedule is outlined in Table 2. The groups in parentheses were assigned to use Knowledge Forum on the back computers.

Small group reading instruction focused heavily on dialogic instruction. For example, a text might discuss the hot and cold temperature on Mercury. The teacher would begin with exploratory talk about what causes differences in day and night temperatures on Earth. As students read paragraphs (either silently or aloud), the teacher would present talking points such as, "What if Mercury rotated quickly?" or "What if

Mercury had an atmosphere?" At the conclusion, the teacher would model day and night on Mercury. In this way, students could discuss how slow rotation, distance from the Sun, and lack of an atmosphere caused extreme temperature changes on Mercury. If students did not grasp this concept on their own, the teacher would guide them through a discussion. In this way, small group instruction included scientific content along with knowledge building and reading strategies.

Table 2. Weekly small group reading and Knowledge Forum schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
10:30	Inner Planets (Black Holes)	Stars A (Outer Planets)	Black Holes (Stars B)	Outer Planets (Inner Planets)	Stars B (Stars A)
11:00	Outer Planets (Stars A)	Stars B (Inner Planets)	Inner Planets (Outer Planets)	Stars A (Black Holes)	Black Holes (Stars B)

While the teacher was working with students in small groups, other children were engaged with independent reading and research. This was the time in which students applied the strategies they had learned during small group reading sessions. During independent reading, children used color-coded post-its to record their thinking and research. In addition, a folder containing a research guide was used to organize post-it notes from books.

Text sources. In small group reading sessions, all students read the same teacher-selected text from Heinemann Library (now Capstone Classroom). Each chapter was two to four pages long, with a heading, subheading, pictures, and captions. Students usually

read one to two chapters per session. Figure 5 shows a chapter from the Earth book in the Universe series (Clark, 2008). Students read these books during small group reading sessions. Additionally, they checked other nonfiction books out of the library to read during independent research.

Figure 5. Sample page from Heinemann series trade book

Unit schedule. The nonfiction unit took place over the course of five weeks during the Spring of 2012, and students posted on Knowledge Forum for six weeks. Children were introduced to knowledge building strategies during minilessons and small group instruction. These included reading new information, questioning a text, thinking about text, and building on to others' ideas. Once students had been introduced to a skill, they practiced using them in small groups with the teacher. Also, they applied skills independently in their own research and Knowledge Forum posts. Students' knowledge building discourse was recorded in an online Knowledge Forum database.

Instructional and distributed scaffolds (research question 2). Children were provided with scaffolds during small group instruction and on Knowledge Forum. In cognitive apprenticeships, materials can serve as scaffolds and help to make thinking visible (Collins et al., 1991). As shown in the conjecture map, research guides and post-its served this purpose during the first iteration. The materials were shared by the knowledge building community, and they helped children to constructively use authoritative text sources.

Research guides and post-its. Reading tools helped students to bring their concepts and ideas from books to knowledge building discourse. In a cognitive apprenticeship approach, materials provide a structure for students in learning a cognitive task. For example, in a regular apprenticeship, students would see a garment or other object take shape with their work. Since children were engaging in a knowledge building cognitive apprenticeship, tools were provided to make their thinking visible. Children had research guides inside a folder. In order to let them organize information on the research guides, students took notes on post-its.

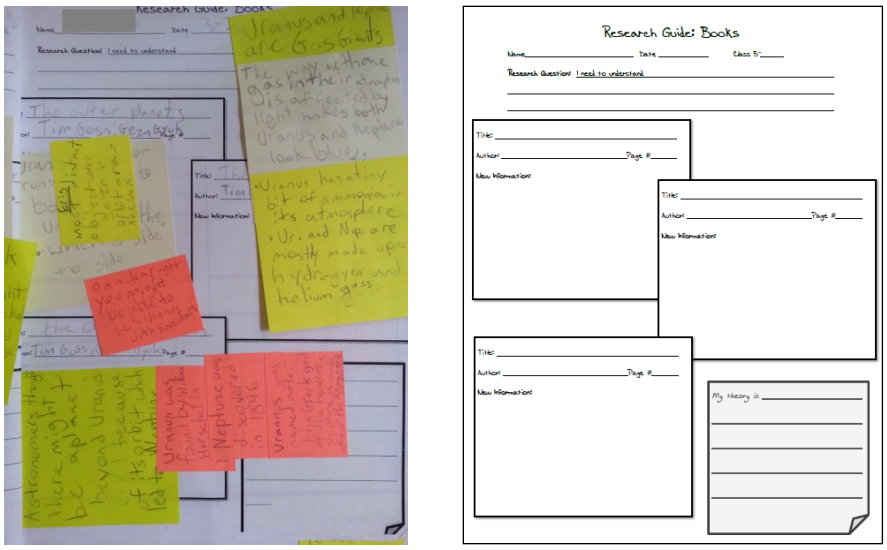


Figure 6. Sample research guide pages

The research guide, developed during pilot studies, was constructed with the goal of helping students to find and rise above texts by developing their own questions and theories. In this way, the research guide gave children space to make connections, develop ideas, and "rise above" the books they read (Zhang et al., 2007). It included separate pages for recording new information and theorizing. Each student kept his or her research guide in a folder, so that it was easy to begin and end research sessions.

Color coding small post-it notes also served to make thinking visible. Red post-its were used for new information. Yellow post-its were to "stop & think" when writing down ideas about a text. Blue post-its were used for recording questions about new information. During small group reading sessions, green post-its were used for building on (really sticking on) to others' notes as they were passed around the table. This served as practice for "building on" to notes in Knowledge Forum. As mentioned earlier, the Research Guide (Appendix G) was meant to scaffold children in generating new ideas from information. Each page of the research guide included a space for information, an idea based on the information, and a theory.

Knowledge Forum scaffolds. Children who were posting on Knowledge Forum could choose scaffolds from a drop-down menu when posting a note. Table 3 outlines the scaffolds available during the first iteration. As can be seen in the screenshot in Figure 7, children could use these scaffolds when posting on Knowledge Forum. Each note in Knowledge Forum could be clicked on and read by others. Students then had the option to either close the note or build onto it with their own new post. For example, in Figure 7, a student had chosen "Putting our knowledge together" as a scaffold for her build-on note about Titan.

Table 3. Knowledge Forum scaffolds for study 1

Theory Building Scaffolds	**Building-On Scaffolds**
New information	Putting our knowledge together
My theory	Related new information
I need to understand	More evidence for the theory
	I disagree because
	I agree because

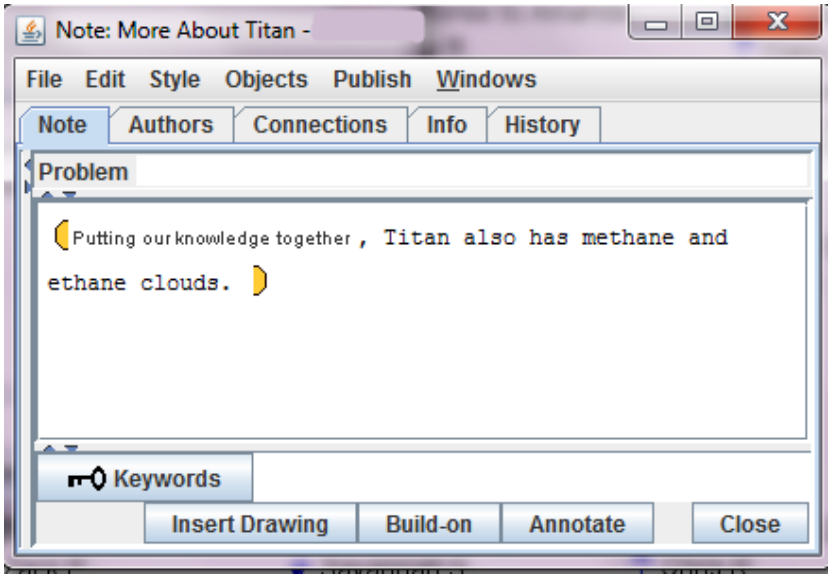


Figure 7. Knowledge Forum post with scaffold

Knowledge building discourse (research question 3). The goal of small group reading instruction, as well as of instructional scaffolds, was to foster knowledge building discourse around authoritative text sources. The methods used to record and analyze such student discourse will be described in the following sections.

Knowledge Forum software. Students used Knowledge Forum software to engage in knowledge building discourse around authoritative text sources. In Knowledge Forum, students had views in which they could post information. The views were "Stars and Galaxies", "Inner Planets", "Outer Planets", and "Black Holes and Dark Matter". The views went along with students' research teams. Four or five students composed each team. Heterogeneous groups were formed that would work well together, both socially and academically.

The Knowledge Forum database provided a space for students to share their knowledge building discourse. Children used the Knowledge Forum database at least once per week during reading time, along with their group. Each group was given a view based on their topic. In addition, children could choose scaffolds to support their research. Figure 8 shows a screen shot from the Knowledge Forum database. The lines between notes represent "build ons" to other students' notes.

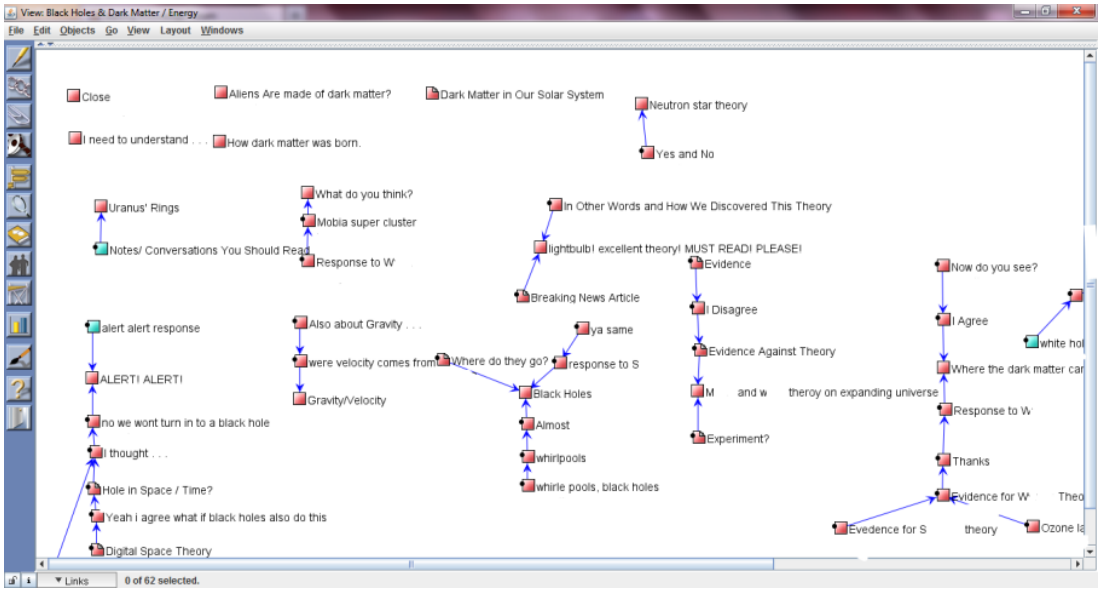


Figure 8. Screenshot of Knowledge Forum database, "Black Holes & Dark Matter" view

Methods of Data Analysis

Scaffolds and instructional design (research question 1 and 2). Analysis of video data revealed whether the model provided an authentic cognitive apprenticeship in knowledge building. Five minute segments of video were reviewed through the lens of a cognitive apprenticeship model. Small group reading sessions were viewed to determine whether students engaged in authentic knowledge building. Ten hours of video data were reviewed in this manner. Field notes were also kept using Microsoft OneNote software. These notes included key observations about students' motivation and engagement.

Reading comprehension tests. Nonfiction reading comprehension tests (Reading A-Z, 2014) were administered to students before and after the intervention. The pretest was titled "The Internet" (Appendix D) and the post-test was "Saving the Salmon" (Appendix F). Each consisted of a reading passage along with ten multiple choice questions and two open-ended questions. The passages were guided reading level S, which was the target independent reading level for midyear in fifth grade. The comprehension tests measured students' ability to 1) apply reading strategies to informational texts, and 2) respond to informational text in writing.

The methods of Study 1 were based on sociocultural theory. The results outlined in the second half of this chapter will be organized based on the original research questions. Analysis of video data and Knowledge Forum notes demonstrated the quality of students' knowledge building discourse. The coding methods for this discourse will be discussed in the following section.

Knowledge Forum discourse (research question 3). As stated previously, students contributed to four different views in Knowledge Forum: "Black Holes & Dark

Matter", "Inner Planets & Moons", "Outer Planets", and "Stars & Galaxies". This Knowledge Forum database was extracted using a Python script (Teplovs, 2013). Next, it was organized based on threaded discussion. Notes which were posted on their own were coded as "new information" notes; those that responded to another post were coded as "build-on" notes. In previous studies, similar inquiry threads had been used to code knowledge building discourse (Zhang et al., 2007). The coding scheme for the current study, outlined in Table 4 and 5, is identical to that used in the second iteration; however, Tables 4 and 5 contain sample excerpts from the first iteration only. As stated earlier, interrater reliability was determined to be 0.71. The entire database from Study 1, 48 pages of students' Knowledge Forum posts, was coded using these tiers. Following Tables 4 and 5, the quality of students' knowledge building discourse will be examined.

Table 4. Coding scheme for "new information" in Knowledge Forum (study 1 examples)

	Code	Definition	Rising Above Text: “New Information” Note Examples
TIER 3	**New information w/ new idea**	Providing new information from an authoritative source. In addition, the new information is used to form a new idea or concept.	Did you know that blue stars are the hottest of all stars? Yellowish white stars are almost as hot as blue stars, and red stars are the least hot. So maybe the sun could be even warmer than it is right now (If that's possible!) . If it did happpen, earth probably wouldnt exist. but if it could happen, the temperature in the winter would be even hotter than the temperature in the summer with a yellow sun, and in the summer, it would basicslly be like living on venus. Ouch! Imagine how many bottles of sunblock you would use up in one day! And dont even get me started with how much sunburn you would get. I know, it would be cool to have a blue sun. It is a cool color! Every day you would find yourself sitting under 20 air conditioners too. You probably wouldnt even be able to go outside!!! NOw that i think about it, i do NOT want a blue sun. Yellow is a pretty cool color, right!
	New info w/ explanation	Providing new information, along with a causative explanation regarding the information.	planet x will not hit earth because we cant see it with a teloscop. so there is a good chance planet x doesent agzist.

Table 4. Coding scheme for "new information" in Knowledge Forum (continued)

	Code	Definition	Rising Above Text: "New Information" Note Examples
TIER 2	**New info w/ connection**	Providing new information, along with a connection to one's own life or knowledge.	New infromation: Note: Mercery has a large iorn core. the core is like a hard boiled egg. Mecerys core is shaped like a ball because it is made of iron and is very dense. Mercerys core is lighter than a rock and has an outer surface called crust.
	New info w/ question	Providing new information, along with a question posed to others about the information.	(Support: New Information) To escape Earth's gravity, you have to move 25,000 m.p.h. This is called the velocity. Unfortunately I don't know why. Do any of you have a theory or info about this?
TIER 1	**New info w/ opinion**	Providing information with an opinion that is not based on fact.	(Support: New Information) Did you know the Sun has an invisible X-ray energy? Hydrogyn gas forms the energy. It takes an X-ray millions of years to reach the Sun's surface. Isn't that awesome?
	New info only	Providing information without asking a question about the information, or making any personal connection or further analysis. For example, facts may be directly from another source.	Did you know that blue stars are the most hot of all the regular stars? Also yellowish white stars are almost as hot as blue stars and red stars are the least hot?

Table 5. Coding scheme for "build-on" notes in Knowledge Forum (study 1 examples)

Code		Definition	Rising Above Text: "Build-On" Note Examples
TIER 3	**Idea based on note**	Using new information provided by another student to form a new idea or concept.	If you look at the picture on page 29 from the book "Stars and Constellations," and you've seen the video we watched on Friday and you recall the time it talked about the "web" which is filled with galaxies and how scientists look at gravity to find the edges of the "web" in space, is it just me or do I think that I see gravitational pulls on the clump of galaxies on the left side of the picture? PLEASE BUILD ON.
	Related information	Providing additional information that builds on to the first student's new information.	Guess what i found jupiters orbit around the sun. It takes 12 earth years to rotate the sun. We should find more info on lenghts of years.
TIER 2	**Evidence-based answer to question**	Answering another student's question, by using evidence based on factual knowledge.	It was discovered by Kelper Telescope, and it was the 22nd planet to be discovered in the Goldalocks Zone. But, Kelper 22-b could be suitable of life. If the tem. are correct, life could be born. Unforunely, it's 4 billion light years away from Earth.
	Agree/ disagree w/ reason	Agreeing or disagreeing with a student's previous post based on factual knowledge.	I think are correct except that scientists did say there was a particle smaller than an atom

Table 5. Coding scheme for "build-on" notes in Knowledge Forum (continued)

Code		Definition	Rising Above Text: "Build-On" Note Examples
TIER 2 (cont.)	**Connection**	Making a connection between new information provided by another student, and one's own experiences or knowledge.	(Putting our knowledge together) this makes sense because W. made a theory saying that there is dark matter inside of atoms, I made a theory that a mini whirlpool sucks like a black hole though the object a mini whirlpool sucks comes back up, and with the help of M. we think that when a black hole sucks something, for ex: a star, it somehow crushes the atoms, causing the dark matter to come out as if a mini whirlpool!!! DOES THIS MAKE SENSE? PLEASE BUILD ON!!!!
	Question	Asking a question about the new information provided by another student.	How hot are the blue stars???
TIER 1	**Opinion- based answer to question**	Answering another student's question based on opinion, or guessing facts without research.	P. asked a similar question. I don't exactly know what it looks like but i am guessing a shooting star. To answer you for size it is probbly as big as a shooting star. So technically, it is just a regular shooting star
	Agree/ disagree w/o reason	Agreeing or disagreeing with a student's previous post without explanation.	Whoops! i guess i am! Thats what my post-it said. so dont blame me (blame the post-it)
	Opinion	Responding to new information with a personal opinion.	In the summer i guess it would be 1,000 degrees! Also, I would be sitting under 16 air conditioners it would be so hot!

Results of Study 1

The conjecture map in Figure 4 on page 30, and the principles in Table 1 on page 31, drove the design of the first study. First, results showed whether instructional methods fostered students' knowledge building. Next, video data from small group reading instruction showed whether children engaged in scaffolded knowledge building with teacher guidance. Finally, discourse from Study 1 was examined using the tiered coding scheme. Knowledge Forum discourse showed whether students created ideas based on informational text sources. The results of the first study, based on the research questions, will be examined in the remainder of this chapter. Later, Chapter 4 will show how the results led to modifications in the second iteration.

Findings on Scaffolds & Instructional Methods (Research Questions 1 & 2)

An analysis of video data revealed whether the model provided an authentic cognitive apprenticeship in knowledge building. Five minute segments of video were reviewed through the lens of a cognitive apprenticeship model. Small group sessions were looked at to determine whether students engaged in scaffolded knowledge building. Ten hours of video data were reviewed in this manner. The materials of the reading sessions can be seen in the figure below, in which students were reading a text using color-coded post-it notes. In addition, the orange cone in the center of the table was used for turn-taking during discussions. Another student can be seen using Knowledge Forum on the back computers.

Figure 9. Small group reading session during study 1

During small group reading instruction, I began by modeling a strategy, such as post-its to "stop and think". Students then often read out loud from a selection, and then they used the orange cone in Figure 9 above to take turns while talking. The purpose of the cognitive apprenticeship was to build knowledge from authoritative texts. As viewed in the video data, the small group reading sessions consisted largely of discussion, with less emphasis on building knowledge from texts.

For example, video data included a 30 minute small group reading session with the "Inner Planets" group. Below are post-its from the guided reading session. First, children all read the same book. Then, I modeled the "stop and think" strategy for students. Students took turns first reading aloud and practicing the strategy, and then reading silently and marking post-its about their ideas. At the end of the session, students passed around the books and "built on" to each other's ideas. Post-its created by one student during this session can be seen in the figure below. On the post-it, the student drew a picture of the Earth's magnetic field. He then inferred that the Aurora Borealis

occurred at the Poles where the field was “open” for particles to pass through. The yellow post-it is a “build on” question posed by another student, and the red post-it is a “build on” by the teacher.

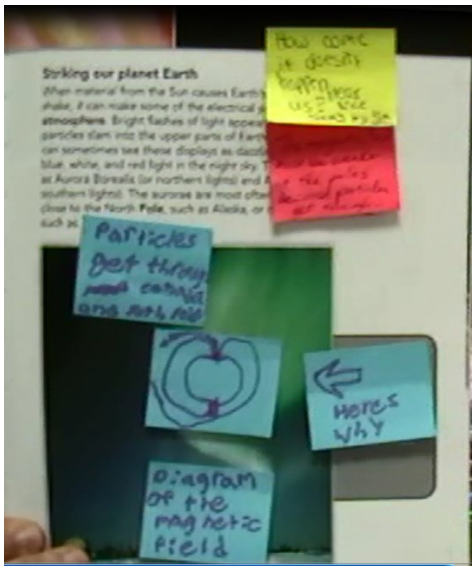


Figure 10. Student post-its from small group reading session

Video data suggests that small group reading sessions did not fully align with knowledge building. For example, the colors for post-it notes did not reflect all of the cognitive work that was done when constructively using authoritative sources. This observation can also be seen in an excerpt from my research journal:

> Next, the third day (Friday) I modeled how to use red post-its for "I Think". This was hard even for me, because the students noticed it overlapped with the blue questions post-its. For example, I wrote "I wonder..." as an red post-it, and C. questioned why it wouldn't be blue. Then I suggested green post-its for connections (self-text, text-text, text-world), and C. looked confused, so I told them red post-its would be for anything you're thinking that the author doesn't say.

In addition, it became clear that it was difficult to scaffold students' use of authoritative sources when we met in fixed research groups. For example, members of each group did not always need to work on the same skill. Also, since I had created heterogeneous groups, members often were reading at widely varying levels. Motivation also varied, since students did not choose the books that we read during small group reading sessions. This was also noted in the research journal:

> Also, I think it would be best to arrange the groups based on guided reading levels. It would be good to have it as an instructional level. Also, it would be best to have it where the students had a lot of choice, and guided reading for the week was a mix of fiction and nonfiction.

In addition to the importance of more flexible grouping during cognitive apprenticeships, I realized that the cognitive scaffolds used during small group reading instruction were not fully aligned with students' knowledge building.

> Also, the scaffolds during book club and in Knowledge Forum should be the same or similar. For example - I can build onto the text by saying . . . I can make a connection to the text by . . . I think about the text . . . I wonder . . . Etc. The post-its could also be integrated into this type of a system with scaffolds.

Use of scaffolds during independent research and small group instruction provided support for student's knowledge building activities. Chapter 4 will show how the instructional design was later modified during the second iteration. Students' knowledge building discourse was based on information directly from text sources. However, later modifications would support them in generating new ideas from authoritative sources.

Findings on Knowledge Building Discourse (Research Question 3)

This section provides evidence to examine the third research question: "How do students engage in knowledge building around informational text sources?" Knowledge Forum notes were coded and analyzed. The results of knowledge building discourse from the first iteration are outlined in Table 6.

Table 6. Quantity of Knowledge Forum discourse for study 1

	Notes per student (average)	Word diversity per student (average)	Total notes written by group (n=23)	Notes read within group	Build-on notes written by group	Average scaffolds used per student	Number of linked notes
First iteration	15	174	342	375	231	2.2	307

An analysis of the online database, run using Java applets within Knowledge Forum (Aguera, 2008; Johnson, 2008; Lea, 2008), provided information on students' knowledge building discourse. The students of the first iteration, or Study 1, wrote a total of 342 notes, and they read (and re-read) a total of 375 notes. Build-on notes represent one student responding to another student's note. The group wrote a total of 231 build on notes. In the first iteration, a total of 7 supports were offered. Students used either a maximum of 4 scaffolds (n=5), 3 scaffolds (n=6), 2 scaffolds (n=4), 1 scaffold (n=3), or no scaffolds at all (n=6). In the first iteration, 307 notes were linked to each other.

Quality of knowledge building discourse. The quality of students' knowledge building discourse was analyzed using a tiered coding scheme. The interrater reliability for was determined to be 0.71 based on coding of Tier 1, Tier 2, and Tier 3 notes.

New information notes. Knowledge Forum notes were analyzed using the coding scheme in Tables 4 and 5. In both cases, "new information" notes were posts started by an individual. "Build-on" notes, on the other hand, were notes that were written in response to someone else's note. The "new information" notes were identified because they were the first notes to begin a thread.

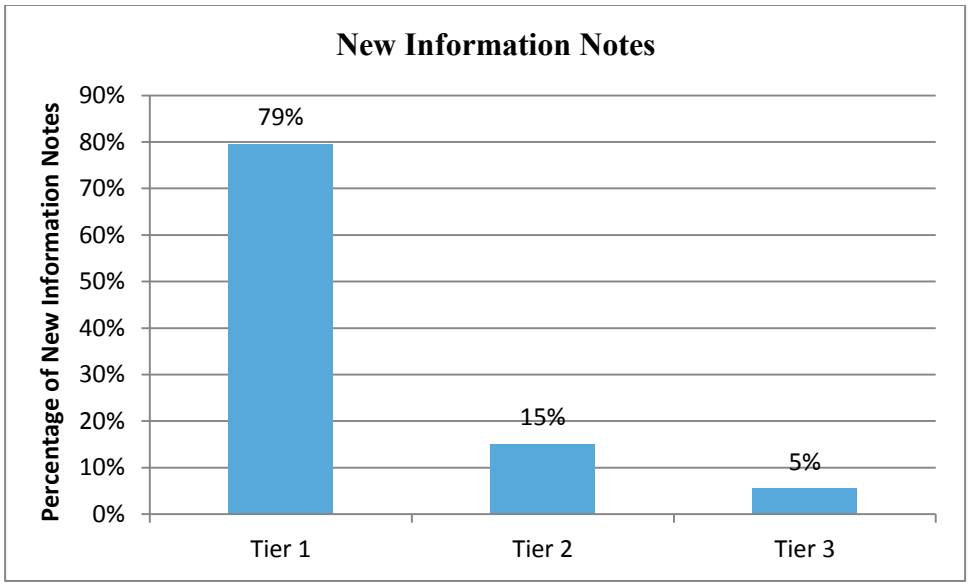


Figure 11. New information notes for study 1

Based on the tiered coding scheme, the majority of knowledge building notes on Knowledge Forum during the first iteration consisted of Tier 1 notes. These were "new information only" or "new information with opinion". Very few posts, only 5%, were Tier 3 notes (new information with an explanation or an idea). This shows that although students were sharing new information, they were not rising above, or generating new ideas, based on text sources. Similar results were found with the build-on notes in their knowledge building discourse.

Build-on notes. Students posted build on notes by replying to another note. Figure 12 shows the Tier 2 and Tier 3 build-on notes broken down into their subcategories. It can be seen that the majority of Tier 2 build-ons in the first iteration were questions. Even though these questions drove the knowledge building discourse by encouraging others to respond, they did not offer additional ideas, explanations, or reasoning. The majority of Tier 3 build-ons during the first iteration were related new information. Students posted related information in 16% of build-on notes, and generated new ideas from information in 3% of build-on notes.

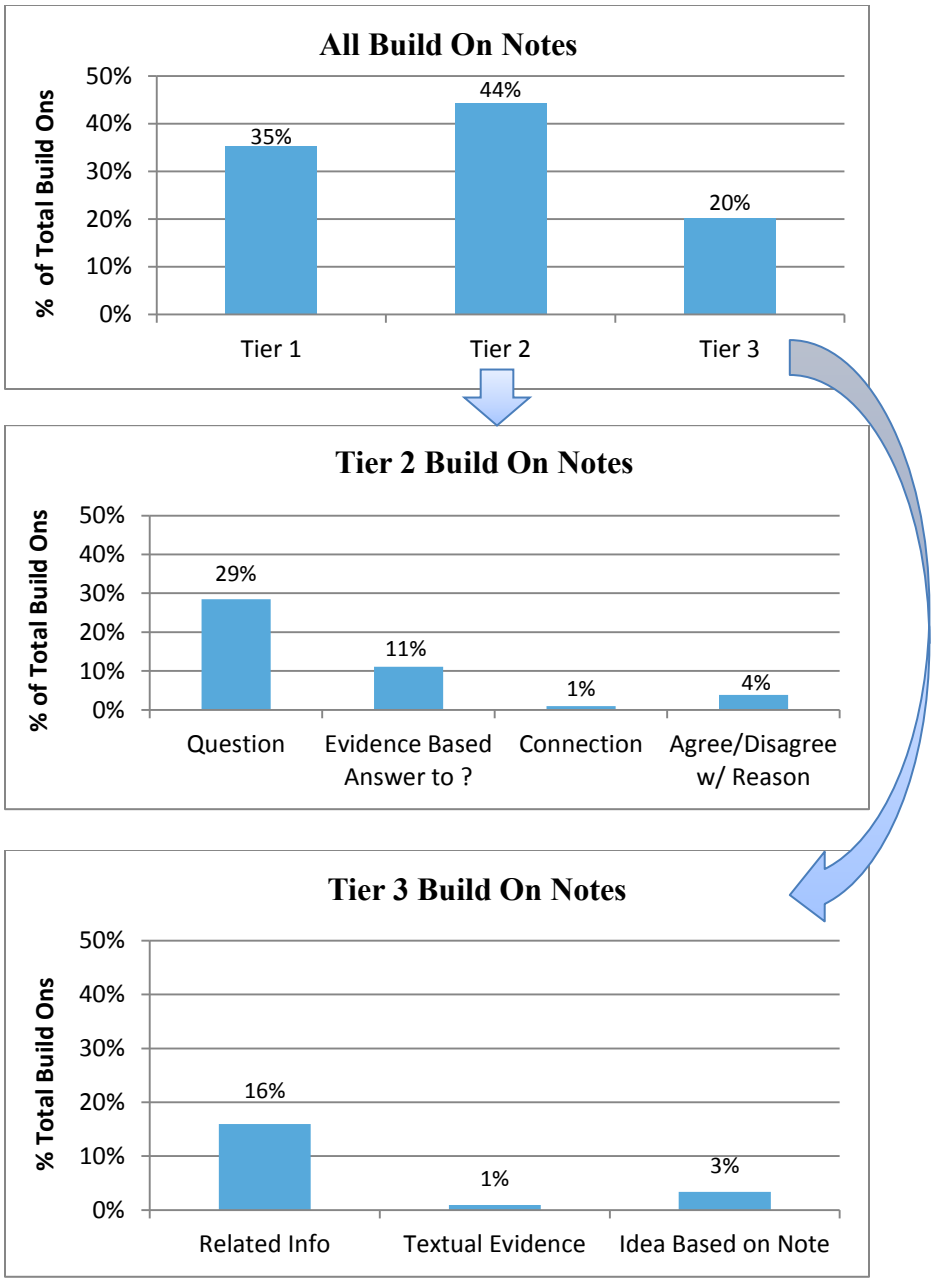


Figure 12. Build on notes for Study 1

Students engaged in knowledge building discourse, sharing new information with other members of their group. However, a low proportion of notes featured high-level idea generation. Their new information notes were mostly Tier 1, consisting of opinions

and information straight from books. The majority of Tier 2 and 3 notes were questions and related information, leading to a question-answer-response type discourse. In this discourse, children mostly asked questions and others replied with related information. The threads read like lists of information, with little idea generation. For example, the post below about Ganymede was answered by both a question and related information. First, a student (in blue) contributed new information about Ganymede, Jupiter's moon. Two students replied: one (in green) posed a question, and another (in purple) provided additional related information. However, the threads continued with one more post each, neither of which developed a new idea or explanation. This discourse was typical of the first iteration.

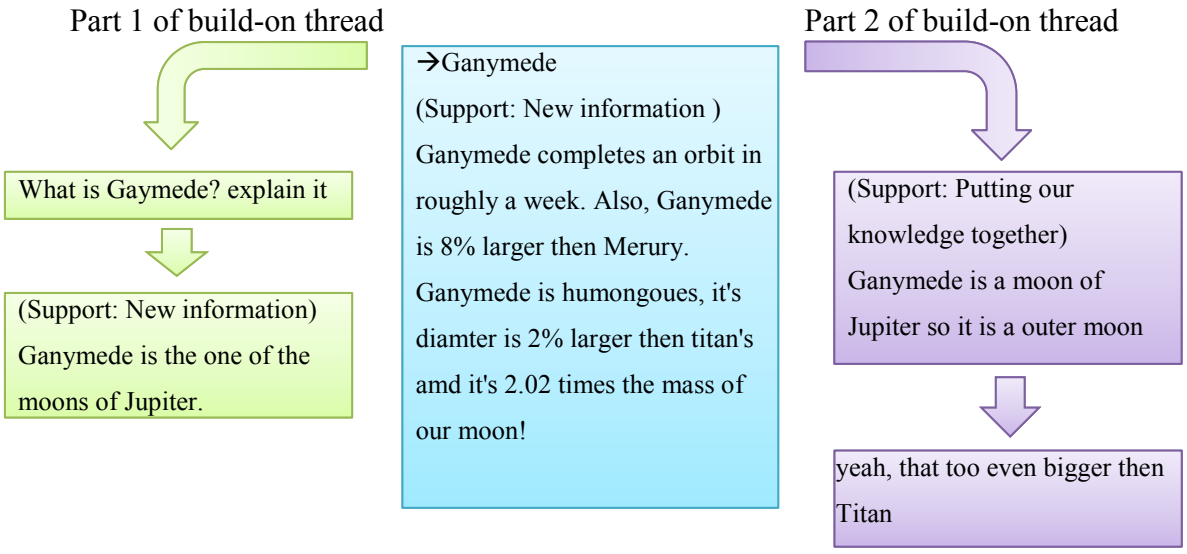


Figure 13. Knowledge Forum thread from study 1

When students did generate ideas, they did not frequently back them up with evidence. For example, Figure 14 shows a thread in which students generated ideas that were not based on evidence from authoritative sources.

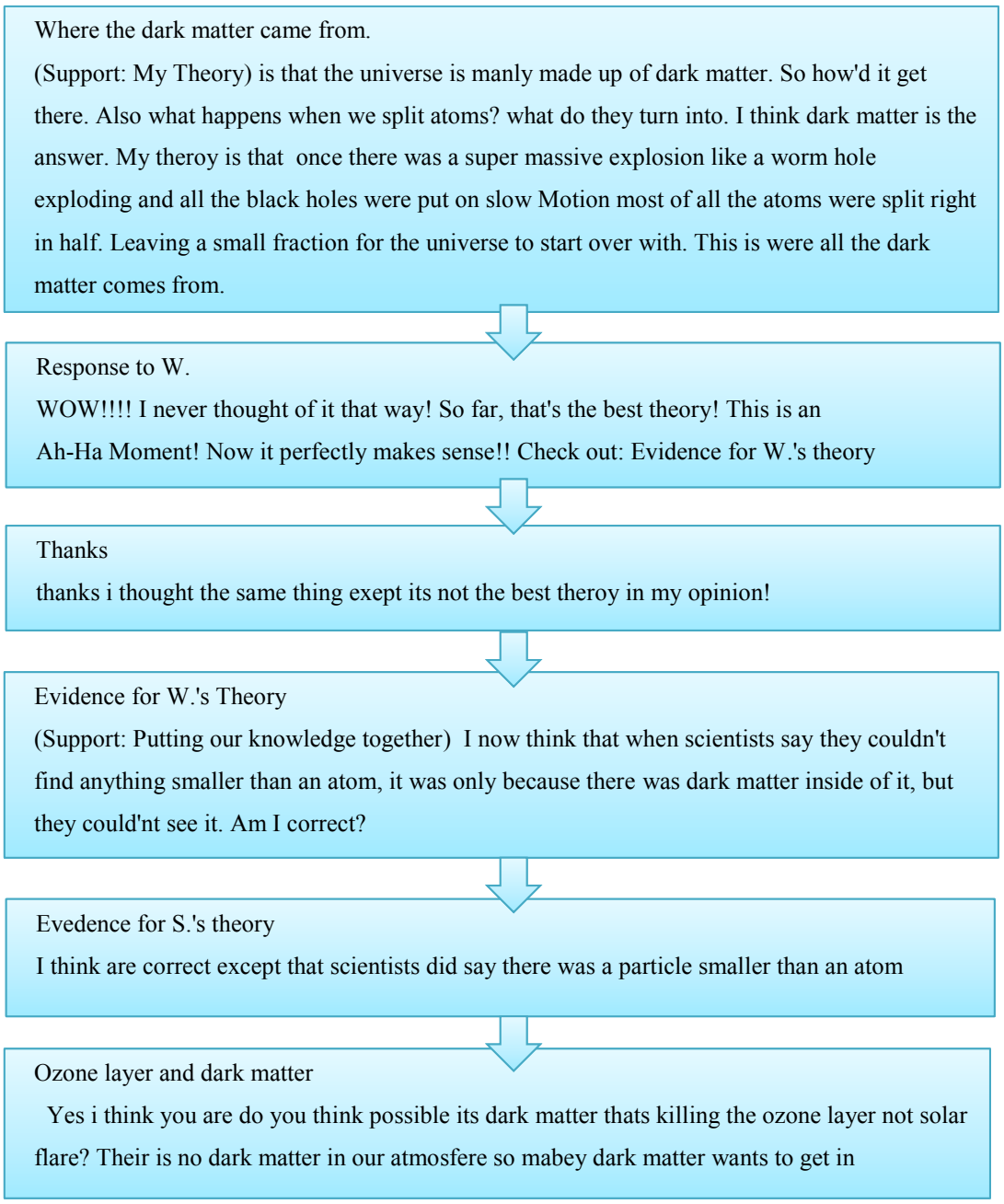


Figure 14. Knowledge Forum thread from study 1

Development of Reading Comprehension

Reading comprehension tests showed whether children met curricular standards during small group reading instruction. Test scores of informational text pre- and post-tests were compared. Students' reading assessments were scored based on percentage of correct multiple choice questions (Appendix D & F). Both pre- and post-test scores were available for 19 students. The raw scores showed a decrease between pre-test scores (M = 81%, SD = 14.6%) and post-test scores (M = 73.6%, SD = 15.7%) of reading comprehension. There was no significant difference between the pre- and post-tests ($t = 1.602$, $df = 18$).

Discussion for Study 1

The original purpose for the first iteration was to develop principled practical knowledge (Bereiter, 2014) about fostering knowledge building with text sources. The instructional design of the first iteration was based on principles. Many findings were useful, and some suggested the need for modifications. By looking at the instructional design's aligned with knowledge building, the results of this study led to refinements in the second iteration.

Instructional design (question 1). The design of instruction showed areas of strength that were later improved upon in Study 2. First, small group reading instruction scaffolded children's ability to build knowledge from text sources. Video excerpts showed the students and teacher discussing higher level ideas that were not found in the text, such as the reason for the shape of Earth's magnetic field. As stated earlier, the post-it in Figure 10 on page 49 was drawn during a discussion on the magnetic field. Through collaborative discourse along with the text, the students and I realized that the Aurora

Borealis might appear in the sky where the magnetic field was weakest. I also modeled knowledge building discourse for students during these small group sessions. All of these factors were continued in the second iteration. However, the small group model posed some constraints as well.

As part of a cognitive apprenticeship, children did not have enough opportunity to engage in authentic knowledge building discourse. In knowledge building, children choose their own text sources. In the small group instruction, the teacher selected the text for the group. Since children were reading the text for the first time, and all students were reading the same book, it was difficult for them to engage in authentic knowledge building discourse. Furthermore, discussions were started and led by the teacher. For these reasons, children needed more opportunity to lead their own knowledge building discourse.

Instructional scaffolds (question 2). The scaffolds developed in Study 1 supported children's knowledge building activities. First, post-it notes allowed children to transfer new information and ideas from a text source to their own, personal knowledge building space (a research guide). Also, the research guides served as a place for children to form concepts by organizing post-it notes. Finally, children used Knowledge Forum scaffolds to guide their thinking and discourse. However, some improvements were needed regarding scaffolds in the first iteration. The post-its, although useful for transferring ideas from books, were small and limited students' writing. Also, children often forgot the color-coding of post-it notes. Finally, students often ignored boxes on the research guides, instead using them as a place to keep notes without categories. All of these issues were taken into account during Study 2.

Knowledge building discourse (question 3). Small group instruction, in which children talked about books along with the teacher, helped students in creating new knowledge based on text sources. However, children did not have other planned opportunities to engage in discourse outside of Knowledge Forum. The results of Study 1 also showed that students did not frequently generate ideas in their knowledge building discourse. A large portion of students' new information posts on Knowledge Forum were Tier 1 notes. Since Tier 1 consisted of either new information only, or new information with an opinion, children were not rising above texts and making inferences. In addition, build-on notes largely consisted of questions or related information. Students' discourse assumed a type of Initiation-Response-Feedback quality without building knowledge from texts. During Study 2, children would be given more opportunity to collaborate with peers during face to face knowledge building discourse.

Based on these results, the cognitive apprenticeship was modified in the second iteration. As will be shown in Chapter 5, the modifications were even more successful at fostering idea generation during knowledge building discourse. An analysis of knowledge building discourse from the first iteration, along with an examination of sociocultural principles, helped to modify the instructional design. Rather than being viewed on their own, the results of study 1 were used to create the methods of study 2 as part of the iterative design process. Based on the study described in this chapter, the design of the second iteration will be outlined in Chapter 4.

CHAPTER 4: RATIONALE AND METHODS OF STUDY 2

As reviewed in the previous chapter, an iterative design approach allowed the refinement of pedagogical methods based on sociocultural principles. A careful analysis of the Knowledge Forum discourse and small group reading video data from study 1 led to the Methods and Results described in this chapter. The second iteration, or study 2, was based on the same principles as study 1. These principles are outlined in Table 7 on page 63. However, modifications were made to better support the underlying principles of the design study. These modifications are highlighted in Figure 15, the conjecture map for study 2. Chapters 4 and 5 will describe the Methods and Results of study 2, and will show how students' collaborative knowledge building was scaffolded during reading instruction.

Rationale for Modifications between Iterations

The results of the first iteration, which were examined in the previous chapter, led to changes in the instructional design. The conjecture map in Figure 15 represents the design of the second iteration; modifications to the original design are highlighted in blue. The rationale for these modifications will be explained in more detail in the following sections. All principles remained the same. However, methods were changed to provide children with more opportunities for collaborative knowledge building.

In this study, knowledge building was combined with a cognitive apprenticeship model to help children learn knowledge building practices. However, relying on small group reading instruction alone presented some challenges in scaffolding children's discourse. In the first iteration, all children read the same teacher-selected texts during

small group instruction. Furthermore, they were introduced to the texts for the first time during small group instruction. Due to this, children did not have time to formulate ideas and theories based on the texts. In the second iteration, children referred to their own books during conferences with the teacher. The research guides used in the first iteration, although a useful tool, did not provide an open-ended space where children could construct their own theories. Instead, students were required to fill in a set number of pages and "new information" boxes. For this reason, the model was reviewed in developing methods for the second iteration in which students used reading journals. Children were also provided more opportunities for face-to-face knowledge building.

The conjecture map (Sandoval, 2014) shows changes to the procedure highlighted in blue. The knowledge building cognitive apprenticeship was further modified in this iteration. First, children worked with their own self-selected texts and research during cognitive apprenticeship meetings with the teacher. This allowed more authentic knowledge building discourse to occur during face-to-face reading conferences, since members of the group were discussing their own new information and ideas. Also, it gave students more opportunities to engage in knowledge building discourse outside of the Knowledge Forum environment. Furthermore, reading partners were assigned to discuss their research on a day-to-day basis. Whole class minilessons on the carpet focused on discussing research with partners, and anchor charts posted in the room outlined strategies for partner discussion. Table 7 summarizes the tools, materials, and participant structures behind the second iteration. The underlying principles, however, are identical to those of the first study.

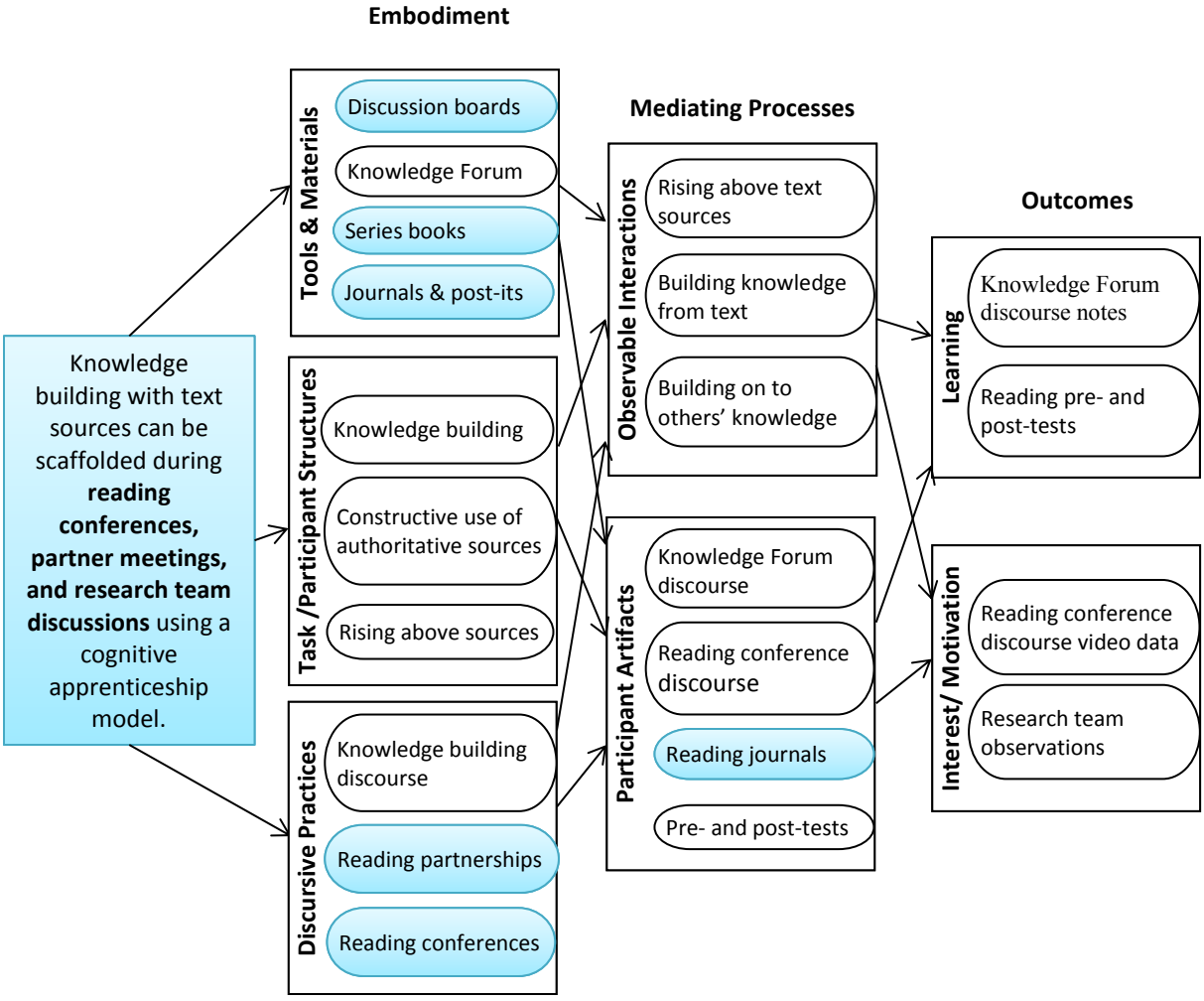


Figure 15. Conjecture map for study 2

A balanced literacy approach, sometimes referred to as the reading workshop model (Calkins, 2001; Calkins, 2011; Fountas & Pinnell, 2006; Porath, 2014), was applied to knowledge building with text sources during the second iteration. The underlying principles of the model are sociocultural. Children are taught how to discuss their thinking about books, and are able to select their own books for independent reading. For this reason, the children could participate in a cognitive apprenticeship while researching with their own self-selected texts. Research principles are outlined in Table 7.

Table 7. Principles driving study 2

Sociocultural Theory	Tools & Materials	Participant Structures
Cognitive apprenticeship		
Method		
Modeling	• Use of post-its to record information and thinking • Use of journals to organize information	Teacher models reading strategies and knowledge building heuristic strategies during reading conferences
Scaffolding	• Knowledge Forum online scaffolds • Discussion boards	Fading of dialogic (discussion board) scaffolds during Reading Conferences
Sequencing		
Increasing complexity	• Begin with series texts built around key concepts	Model taking notes with ideas, to organizing ideas, to developing major concepts and theories from ideas
Sociology		
Community of learners	• Knowledge Forum • Discussion boards	• Reading conferences • Reading partnerships • Group discussions
Knowledge building		
Knowledge building discourse	• Within Knowledge Forum • During reading conferences • Within reading partnerships and research groups	Discuss students' independent research during reading conferences
Constructive use of authoritative sources	• Students read and discuss their own books during reading conferences	Students begin with series books, and then continue to wider library and Internet research.

Procedure

Participants and Setting

This iteration took place in the same school as the first study, with my pre-existing fifth grade class during the 2012-2013 school year. During the time of the study, 23 students were enrolled in the reading class. One student had moved from out of state at the beginning of the year, so did not have NJASK data from 2011-2012. The students were 10 girls and 13 boys, aged 10 – 11.

Instructional Design Methods (Research Question 1)

This second iteration was integrated with a balanced literacy approach to reading instruction. This included self-selected independent reading, small group instruction, teacher-student reading conferences, as well as partner and group meetings. Each reading session began with a whole class minilesson on the carpet. Students were assigned reading partners with whom they discussed their research on a regular basis. Also, each student conferred with the teacher at least once each week. Both children's knowledge building and reading comprehension were scaffolded during conferences.

Figure 16. Students engaged in knowledge building during balanced literacy

Reading conferences. Reading conferences were based on the Reading Workshop conferencing model (Calkins, 2011). During reading conferences, children came to the front table with their books, post-its, and journals. Instead of reading a new text, they worked with the teacher in building knowledge from their own texts. In addition, as in the cognitive apprenticeship model, the sequencing of modeling and scaffolding grew in complexity over time.

During conferences, I met with students on an as-needed basis to go over skills, strategies, and dialogic instruction. Conferences were set up around a central structure. The teacher modeled a strategy, students practiced it, and then the students were sent off to apply the strategy on their own. Conferences were with one to four students. There was no set schedule, but students were called if they were having difficulty with knowledge building research. Also, each student had at least one conference each week. Sometimes, students were called if they were working on similar strategies. Still other times, they were called together if they were in the same research group, especially if we were working on dialogic instruction.

Conferences included both dialogic instruction and reading strategy instruction. Dialogic scaffolds were used to foster students' discussions about new information they learned from informational text. These scaffolds included teacher modeling, teacher questioning, and discussion boards with response starters. In addition, students also received reading strategy instruction during conferences. These topics included making sense of nonfiction text features, writing down ideas, and making inferences. The content of conferences will be described in more detail in chapter five. Usually, conferences were a combination of dialogic and reading strategy instruction.

Minilessons. A component of balanced literacy, minilessons began each session of reading instruction. During this time, students came to the carpet with their nonfiction research book. First, the teacher would model a skill or strategy that the students needed for nonfiction reading comprehension and/or knowledge building. The minilessons included nonfiction reading strategies and dialogic methods (Appendix H). Next, students had a chance to practice and apply the new strategy. Sometimes, "anchor charts" or posters were created to help students remember the strategy. These 10 to 20 minute lessons were a chance for the whole class to meet at the beginning of each reading session. Many of the minilessons came directly from the fifth grade curriculum (Calkins, 2011). However, a number of minilessons were created that related specifically to knowledge building. Often, reading conferences provided students with extra time to apply a new strategy. When I did not have specific lessons to work on during conferences, I continued with the minilesson objective.

Children were divided into flexible research groups which engaged with each other in knowledge building discourse. That is, groups primarily researched one topic, but they could also read about and post in other groups' topics. Children were also assigned a reading partner from their research team. This was a continuation of reading partners from the Reading Workshop model, in which partners often met to discuss their post-its, retell sections of books, and discuss their thinking about texts (Calkins, 2011).

After independent reading sessions where the teacher met with individuals and groups during reading conferences, partners frequently had 5 to 10 minutes to discuss their independent research and reading. As the weeks progressed, these reading partnerships blossomed into whole groups reading and discussing together. At times,

groups would request the front table during brief partnership meetings. For this reason, children had the opportunity to engage in knowledge building discourse in a face-to-face environment without teacher scaffolding. In the first iteration, the social structure of the classroom had only allowed students to engage in knowledge building discourse with either teacher scaffolding during small groups, or independently on Knowledge Forum.

Series books. First, we used Capstone Heinemann classroom series books. Books were organized by guided reading levels (Calkins, 2011; Fountas & Pinnell, 2006). The target instructional fifth grade level for December was S/T, and students' levels ranged from R through Z. The Universe series was level X, but was easily accessible by students reading at the level S/T/U guided reading level. These nonfiction series may have been rated at a higher level because of the vocabulary, but once students became familiar with the terminology, children read them easily. The repetitive structure of the series books made research easier at first. Later, during the third and fourth weeks, students often looked for other books in the classroom or school library. Another series was Food Chains, guided reading level Q/R. Another Life Cycle series, at the W/X/Y guided reading level, supplemented this topic. The Chemistry series was level X, but in the past had been leveled as S. Again, like the planets books, the higher leveling may have been due to content specific vocabulary. We did not have history series books, but did have history books in the classroom library. Many students in the history group chose to read DK (Dorling Kindersley) Publishing series books, which were mostly leveled W through Z. Also, we did not have series books on animals in the classroom.

During the first week, students were separated into knowledge building groups based partly on series books available. They were offered a choice of research topics and

chose their first, second, and third topics on a piece of paper. I formed groups that I thought would work well collaboratively based on reading level and interest. Also, fewer students wanted to research chemistry (n=3) or history (n=5), so they were given their first choice. The food chains group was so large that we separated it into food chains and animals, so students often ended up working together within those two groups.

Timeline. The study took place during the scheduled nonfiction reading unit for fifth grade during December, 2012, and January, 2013. It occurred right after the benchmark reading assessments. The study overlapped the winter break. Since the study was implemented during the fifth grade nonfiction unit, other classes were engaged in the nonfiction unit at about the same time (albeit without Knowledge Forum, or knowledge building extensions and minilessons). We began the unit on Wednesday, December 12, 2012. During the first week, students were introduced to the nonfiction genre. They learned how to write nonfiction stop & jots (post-its). Previously, based on another teacher's idea, they had learned to write gold, silver, and bronze post-its during the fiction unit. Now, this was transferred to nonfiction. We used the same terminology of "ideas and evidence" as we had with fiction. Right before the winter break, we formed research groups during a minilesson and constructed a chart that would later be used for the Knowledge Forum schedule. Students' class numbers were written on post-its underneath their research topics. Each week, I included at least one minilesson focusing on a nonfiction reading strategy, such as main ideas and details.

After viewing video excerpts during the winter break, I realized that most of the talk during conferences was teacher talk. Students contributed short utterances when asked questions by the teacher. I developed minilessons during the second month that

fostered student discussion. Also, I created a discussion board that students could use as a scaffold when meeting with their group. This scaffold later transitioned to an online scaffold when students used Knowledge Forum. Other than that, the methods for the second iteration remained in place. This went seamlessly, and balanced literacy blended very well with knowledge building. The existing Reading Workshop nonfiction unit would have been for children to discuss their own, independent nonfiction reading with one partner (Calkins, 2011).

Many of the lessons after the vacation were focused on dialogic instruction, such as talking with a partner and how to talk about nonfiction books using discussion boards. We had planned to use Knowledge Forum during the week back from vacation, but the database was down so began the following week. At that time, students began using Knowledge Forum at least once per week for forty minute segments. Next, we talked about generating big, new ideas based on a group's research. Finally, during the last week, students continued using Knowledge Forum. Minilessons focused on narrative nonfiction, and I assessed students' reading levels in individual reading conferences.

Unit schedule. The sequencing of instruction of the second iteration was based on the cognitive apprenticeship organization of "lower to higher complexity" (Collins, 2006). For this reason, the sequence began by helping children to generate ideas from one text. In the Reading Workshop curriculum, units are often separated into week-long segments (Calkins, 2011). During these segments, children deal with more complexity associated with text genres. The way in which the segments were organized to range from lower to higher complexity is described below. The weekly sequences described in the following section were not set in stone, and they were flexible based on student readiness

during conferences. For example, some students were still working on organizing post-its while others generated big ideas. Throughout the course of the unit, children also worked on nonfiction reading strategies during conferences. Many strategies were first introduced in minilessons (Appendix H).

Weeks 1-2. During the first two weeks, the teacher showed children how to record and think about information from single texts. Children were separated into research teams based on their first, second, and third choices in the same manner as in the first iteration. During minilessons, they learned how to write post-its that included both information and ideas. In reading conferences, the teacher helped students to write post-its containing questions and ideas along with new information. Unlike in the first iteration, where "new information" was a red post it; in the second iteration, new information was always included along with one's own ideas on a post-it. This helped create a way of making thinking visible, and ensured that students were thinking about the information they were reading. Students engaged in face-to-face knowledge building discourse at this point, in preparation for online discourse using Knowledge Forum.

Weeks 3-4. During weeks three and four, the teacher showed children how to organize research and ideas from multiple texts. To generate ideas and see concepts in information, children learned to organize post-its in their reading journals. Again, this was first modeled during a minilesson, and later practiced with teacher guidance during reading conferences. Children created sub-headings in their journals, and then divided post-its into the headings. This allowed them to see connections and to generate bigger ideas. Students began using Knowledge Forum at this time. During the third week, one member from each group went on the computer, so that only one student would be

posting in each view at a time. This reduced complexity. Beginning in the fourth week and continuing for the remainder of the study, children from the same research team posted on Knowledge Forum on the same day in a collaborative environment.

Weeks 5-6. Finally, during weeks five and six, children worked on generating big ideas based on their research. During a minilesson, teams worked together and, sitting in a circle, looked through their journals to generate big ideas about their concepts. They looked for overarching principles and theories in their research. This was also done during reading conferences as well. During the course of the unit, the cognitive apprenticeship progressed from facts, to concepts, to big ideas based on text sources.

Daily schedule. Each daily lesson was based on the reading workshop model. First, I introduced a reading strategy or skill during a minilesson. I modeled the strategy, and gave students a chance to discuss and practice. After this, they went off to read their own books for 30 to 45 minutes. During the independent reading time, students used post-its to take notes in their books. Often, groups chose to sit next to each other in a circle while reading and researching. They had the opportunity to read fiction after about half of the reading time was done, but most chose to continue reading nonfiction.

While students were reading and taking notes independently, I conducted the videotaped reading conferences. Students were familiar with the reading conference model, since they had been using it all year. I scheduled conferences with students to 1) try to meet with each student at least once per week, and 2) meet with students who were struggling or stuck. For example, some students were not writing on post-its, which prompted a conference about place-marking with smaller post-its. During this reading and conferring time, beginning in the third week of the study, students were assigned to

work on Knowledge Forum for an entire reading class.

During the first Knowledge Forum session, I assigned one student per each research group so that they could become familiar with the program. After that, groups worked together at the same time in the Knowledge Forum space. Throughout the unit, students knew that they were collecting post-its and information to add to the knowledge of their group. After the reading and conference time, sometimes students had a chance to meet with their group for discussion. They shared post-its and discussed their findings during this time. In the third through fifth week, students used their discussion boards to scaffold partner discussions.

Instructional and Distributed Scaffolds (Research Question 2)

The reading classroom was set up with tools to scaffold students' knowledge building. First, they had access to books on various research topics. The series books were found to support knowledge building, as they fostered collaboration around shared texts and knowledge. Also, journals and post-its served to make thinking visible so that students could rise above text sources.

Journals and post-its. In the second iteration, children used reading journals and post-its to record their new information and ideas. These are tools outlined in the Reading Workshop model (Calkins, 2011). First, instruction focused on writing thinking and evidence on post-its. Students wrote about their thoughts and ideas from the books, along with textual evidence, as they read. Beginning in the second week, instruction focused on helping them to create subtopics to categorize post-its. This helped them to generate ideas and to synthesize information from multiple texts. In Figure 17, a post-it reads, "As I am reading I could make ideas," showing a student's thinking about the book.

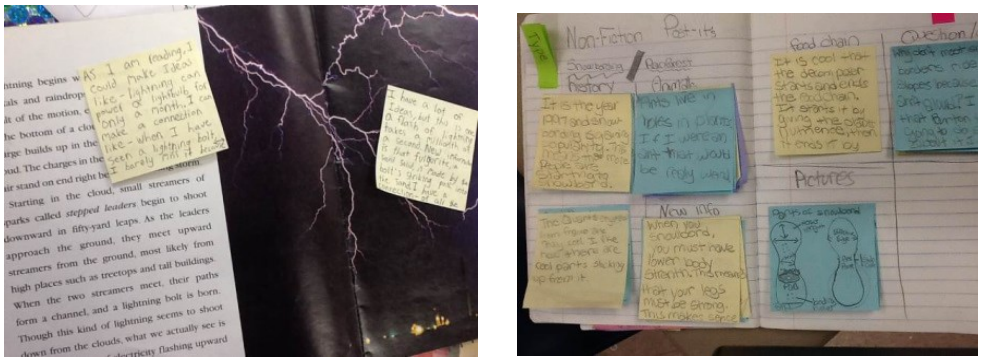


Figure 17. Student post-its in book and organized in research journal

Anchor charts. Charts that were constructed during minilessons were hung up in the classroom. First, one chart instructed students on how to write "gold post-its" while reading and researching. It was important for students to include both an idea and evidence on a post-it. By thinking about texts while researching, the post-its scaffolded students' Knowledge Forum notes and knowledge building discourse. Later, children viewed the second anchor chart. This showed them how to use their reading journal for writing Knowledge Forum notes. Instead of sharing information directly from books, students looked at post-its when posting on Knowledge Forum. In this way, they were able to share their thinking about books. In addition, students were provided a worksheet scaffold for their first Knowledge Forum session (Appendix A).

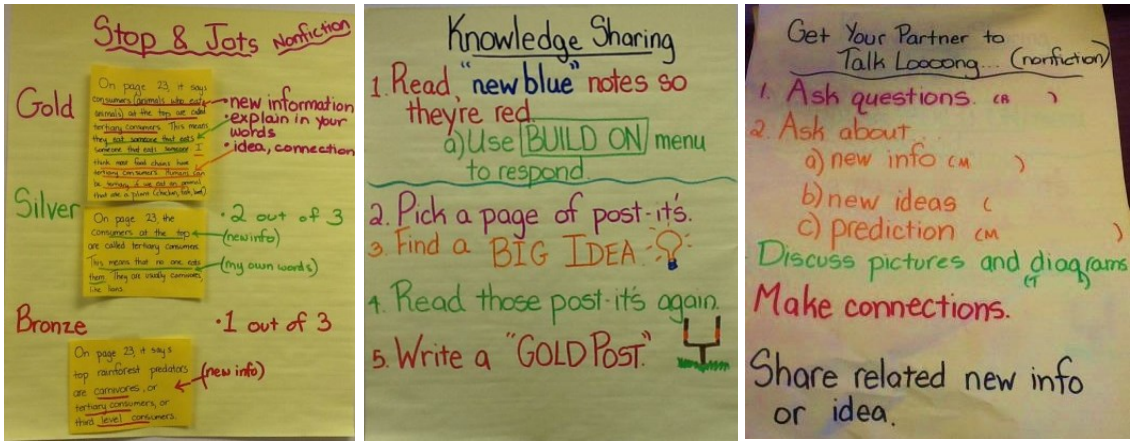


Figure 18. Anchor charts for posting in journal (left), posting on Knowledge Forum (center), and discussing books with a partner (right).

Discussion boards. The discussion board (Appendix B) served to scaffold students' discussion during reading conferences and meetings with their reading partners. The boards were at first meant to be a game where students tried to cover up squares. Instead, most preferred to leave them open during discussions to give them ideas for responses. The boards contained two parts. The top part provided starters for students to use in introducing new information. These starters were similar to scaffolds used in Knowledge Forum, and provided children with a way to begin to engage in knowledge building dialogue in a face-to-face environment. The bottom portion provided methods of responding to new information provided by someone else. This bottom portion was parallel to the "build-on" scaffolds in Knowledge Forum.

Students were introduced to the discussion board in a minilesson. Next, they had a chance to practice using it as a whole class. It was frequently used in reading conferences, and students also used it when meeting with their reading partner. The discussion board was introduced before Knowledge Forum, and was then slowly faded as students became familiar with knowledge building discourse.

Knowledge Forum scaffolds. Based on observations made in a research journal during the first iteration, I used the Knowledge Forum scaffolds that naturally transitioned students from the physical work they were doing in their journals. During the previous fiction unit, we had spoken about stating ideas about characters and setting based on evidence from the text (Calkins, 2011). This strategy also applies to nonfiction. Therefore, one Knowledge Forum scaffold was "Idea + Evidence". We used the same language when talking about what went on student post-its. Students learned that post-its

should contain information from the text, along with an idea. Also, they were prompted to write post-its using new information they learned while reading, instead of repeating information that they already knew. This supported later knowledge building with Knowledge Forum, where participants were adding to the group's body of knowledge.

The Knowledge Forum scaffolds are outlined in Table 8. Students began by focusing on the theory building scaffolds, which flowed naturally from their use of post-it notes and reading journals. To limit off-topic conversations at first, only one person from each research group posted on Knowledge Forum at a time during the first week. During the following week, each group had a chance to go on Knowledge Forum, all together, twice a week. Once they were on all together, we discussed the "building on" scaffolds. Scaffolds were kept simple to avoid confusion.

Table 8. Knowledge Forum scaffolds for study 2

Theory Building Scaffolds	**Building On Scaffolds**
Idea + Evidence	I agree because
I Need to Understand	I disagree because
New Information	A question
My idea	Putting our knowledge together
	Related info
	Related idea

Students did not go on Knowledge Forum until they had been researching their topic and discussing with their group for almost three weeks. The schedule was kept on a

poster in the classroom. Students had two days a week in which they were assigned to Knowledge Forum. Often, they asked to post more frequently.

Knowledge Building Discourse (Research Question 3)

Being design based research, discourse analysis codes were developed upon a review of the Knowledge Forum and video data. As in the first iteration, the knowledge building discourse coding scheme rated the quality of students' discourse based on their ability to rise above text. It was developed using Knowledge Forum discourse, and then applied to students' face-to-face discussions during reading conferences. In each instance, the codes were developed while reviewing the data. Coding categories were also influenced by literacy standards that children were expected to achieve in fifth grade.

Knowledge Forum discourse analysis. The Knowledge Forum codes were developed by reviewing 100 pages of notes from Knowledge Forum discourse. Previous studies had tested children's ability to rise above texts (Zhang et al., 2007). Although not every post in the current study mentioned a text source, children were reading text sources in the context of the unit. As in the first study, the Knowledge Forum database was extracted using a Python script (Teplovs, 2013), and then organized into threaded discussions based on new information and build-on notes. Inquiry threads in previous knowledge building studies had been organized for data analysis based on posts of the same topic (Zhang et al., 2007). Similar analysis of discussion threads was used in this study. However, posts were considered one thread if they were linked with the "build-on" function.

Developing coded "tiers". Codes were developed while reviewing the discourse. First, fine-grained categories were made for "new information" and "build-on" notes. All

notes were separated into six new information categories and nine build-on categories. Next, the categories were combined to provide a clearer picture of knowledge building. After reading students' discourse, it became apparent that certain types of notes advanced the group's knowledge more quickly than others. For example, when students stated new information from books without their own idea, knowledge did not advance rapidly. Similarly, students who offered opinions did not contribute much to knowledge advancement. As can be seen in Table 9, these two types of notes were categorized as Tier 1. They added to the knowledge building space, but did not contribute a lot toward advancing the knowledge of the group. Tier 2 notes, in contrast, served to move knowledge ahead more quickly. In these notes, students made connections between new information and their own lives, or asked questions of peers. Upon reviewing the Knowledge Forum discourse, it was found that explanations and ideas based on information served to move knowledge advancement ahead most quickly. In this way, fine-grained scaffolding codes were organized into tiers. All notes contributed to discourse, but the higher tiers moved the knowledge of the group ahead more quickly.

Group comparisons. Applets within Knowledge Forum allowed for comparisons to be made within groups. Within the Knowledge Forum database, students were organized into different "groups" between iterations. In this way, I was able to compare discourse between the two iterations. Next, different "views" within the second iteration were compared, showing how knowledge building discourse varied within the second iteration. A Writing applet analyzed average number of notes written, as well as word diversity per student (Lea, 2008). A Contribution applet compared build-ons, notes created, notes read, and notes linked (Aguera, 2008). Finally, a Social Networks applet

illustrated connections between students, including notes read and built onto by others (Johnson, 2008). Comparisons were made between the two iterations, as well as between research "views" of the second iteration. The results of these comparisons will be discussed in the Knowledge Forum discourse section of Chapter 5.

Threaded discussion. The grain of coding was each individual's note; however, threads were also visible in the coding. First, I laid out the threads by extracting the Knowledge Forum database for each view. Since build-ons and opening threads were coded differently, it was possible to analyze and visualize the length of threads. The "New Information" coded notes began a discussion, and the "Build-On" coded notes contributed to an existing thread. Reading informational text is a major component of the Common Core State Standards. Furthermore, fifth grade students are expected to use evidence to make inferences from nonfiction text in standard CCSS.ELA-Literacy.RI.5.1 (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). The ability to make inferences from text was rated using three tiers.

Introducing a thread. Students who began their own thread were coded using the following methods. Since the goal was for children to constructively use text sources, the codes were rated based on the quality of their ability to rise above. Tier 1 notes were "new information only" and "new information with opinion". Tier 2 notes were "new information with question" and "new information with connection". Tier 2 notes demonstrated children were thinking about texts and moving the group's knowledge building forward. Tier 3 notes were "new information with explanation" and "new information with new idea". In these notes, a student synthesized knowledge based on the

texts. Although children did not always mention books in these notes, they were working with texts within the context of the study. New information codes are outlined in Table 9.

Building on to a thread. Once a student introduced new information, other students could build on to that note. Notes were coded as build-ons if they were attached to another note with an arrow in Knowledge Forum. Students did this by reading another student's note and choosing "build-on" to reply to the note. Like the new information coding, build-ons were also categorized into three tiers. Tier 1, or the least advanced, consisted of opinions, as well as agreement/disagreement with no supporting reason. Tier 2 notes were questions, connections, or agreement/disagreement with a supporting reason. Again, Tier 2 notes contributed to the group's thinking and knowledge. Tier 3, or the most advanced knowledge building discourse, consisted of related information, a new idea based on the original note, or more textual information. Tier 3 responses advanced the knowledge in the community. If a note showed more than one tier, the highest level code was applied. To analyze the discourse, a descriptor code application was run using Dedoose software.

Table 9. Coding scheme for "introducing new information" in Knowledge Forum

Code		Definition	Rising Above Text: "New Information" Note Examples
TIER 3	**New information w/ new idea**	Providing new information from an authoritative source. In addition, the new information is used to form an idea or concept.	I learned that Pluto used to be a planet but now it is a dwarf planet. I think it is because Pluto is the smallest planet in our solar system. I also think that it must have been hard to find Pluto because it is so far away and is so small. I also predict that scientists will find more planets in our solar system. Another thing I learned is that Pluto is 30 times smaller than Mercury whitch is the smallest planet in our solar system! I also leaned that Pluto keeps getting smaller. I think that is because Pluto is so far away from the sun so it is very cold, and I think that because of that part by part Pluto is braking into parts. If I m right I have a connection because it is kind of like frost bite because frost bite is very could and if you get it you could loose a finger or toe. Support: New information
	New info w/ explanation	Providing new information, along with a causative explanation regarding the information.	Did you know that powder dissolves faster than a clump of powder. The larger a solid is, the larger it takes to break down. For example, sugar cubes take more time to dissolve in coffee, but sugar powder takes less time to dissolve in coffee. Most companies make cubes rather than powder so that the powder won't spill out as easily. Support: Idea + Evidence

Table 9. Coding scheme for "introducing new information" in Knowledge Forum (continued)

Code		Definition	Rising Above Text: "New Information" Note Examples
TIER 2	**New info w/ connection**	Providing new information, along with a connection to one's own life or knowledge.	Aztec parents were very strict with their children once they reach an age over 11. Aztec parents sometimes pricked their skin with spines. They also held there children right over a blazing fire filled with chili peppers so the children would have to inhale the strong, spicy fumes. Now, parents only put their kids in time out or yell at them. Support: New Information
	New info w/ question	Providing new information with a question about the information.	Are most wild horses small? Because in most of the horse books I read, the wild horse pictures have very small horses in them! And they're not babies. Support: I Need to Understand
TIER 1	**New info w/ opinion**	Providing information with an opinion that is not based on fact.	In the south during the Civil War there were 9 million people in the south and 3 million of those people were slaves from Africa and other places. The slaves from Africa were forced to leave. Most of these slaves worked on large plantations,They also helped growing food and a lot of other things. And my idea is if the Civil War never happened we would not really like Abraham Lincoln as much,and we would of missed a big part of American history.
	New info only	Providing information without an idea, connection, or question.	Why does all these things change for a woodchuck? Lots of things happen to a woodchuck. One of these things is that during hibernation a woodchuck doesn't have to wake up to eat. This is because by slowing down its breathing and heart rate it uses less energy and can live off its own body fat. Another thing that happens is it's heartbeat changes from 80 beats a minute to 4 or 5 beats a minute. Also it's breathing slows down. A woodchuck takes a breath every 6 minutes in hibernation.

Table 10. Coding scheme for "building-on" in Knowledge Forum

Code		Definition	Rising Above Text: "Build-On" Note Examples
TIER 3	**Idea based on note**	Using new information provided by another student to form an idea or concept.	M., I totally agree with you! I am very curious as to why on earth people would hunt jaguars. They don't have any valuable body parts, such as ivory tusks, and not a signifigant amount of people dine on their meat. My theory is that jaguars are killed mostly for their fur. Humans in the rainforest might create jackets, rugs or blankets out of the furry skin.
	Related information	Providing additional information that builds on to the first student's new information.	I agrea with you T., also did you know that in the day time the moon and the stars are actually still in the sky ,we just cant see them as well because of the brightness of the sun. Support: Related New Info
TIER 2	**Evidence-based answer to question**	Answering another student's question using factual evidence based on factual knowledge.	I think there are 1,000 atoms in a molecule because in my book, Atoms and Molecules, it says so. I'm not sure if my book is right. Please help me research this topic. Support: Putting our knowledge together
	Agree/ disagree w/ reason	Agreeing or disagreeing with a student's previous post based on factual knowledge.	I agree since they have humps to store water and food (Well thats what I think), and other times they hve their fat stored up and live off of that. I know it sounds weird but I dont know as long as they can survive! Support: Putting our knowledge together

Table 10. Coding scheme for "building-on" in Knowledge Forum (continued)

TIER 2 (cont.)	**Connection**	Making a connection between information provided by another student, and one's own life or knowledge.	Gerbils also come out only at night. They remind me of bats, and how bats sneak around at night to find food. ') Support: Idea + Evidence
	Question	Asking a question about the new information provided by another student.	Wow S. that's crazy! I don't think that a human could do that. When we are sleeping does our heartbeat slow down? We would have to get up to eat just like when we wake up when it's morning and it's time to eat breakfast. Do you know how much body fat it has?
TIER 1	**Opinion-based answer to question**	Answering another student's question based on opinion, or guessing facts without research.	10 Days because you can survive a week with out food. I gues they would find a berry bush or something to eat. But I think they would panic and die.
	Agree/ disagree w/o reason	Agreeing or disagreeing with a student's previous post without explanation.	Dear E.,You might be reading this note for a while because you're sick, but I think that my book is right. If you don't agree with me, please consult Ms. Doto.
	Opinion	Responding to new information with a personal opinion.	I think it would be gross to live in the rainforest because you would have to eat animals. Support: I agree because

Reading conference discourse analysis. The Knowledge Forum codes described in the previous section were also used to analyze student knowledge building discourse during reading conferences. In addition, a multistep process was employed to code and analyze video data from reading conferences. First, videos were uploaded to the Dedoose data analysis platform. They were viewed through the lens of dialogic and materials scaffolding. While viewing the videos, excerpts were separated based on discrete scaffolding events. Due to the nature of the data analysis software, one code was applied once to an excerpt regardless if it was repeated during the length of the excerpt. During strategy instruction, excerpts were based on each lesson segment. During dialogic instruction, excerpts were based on one meaningful discussion thread beginning with new information. In addition, each excerpt was also coded for 1) the week in which it occurred, and 2) students who participated.

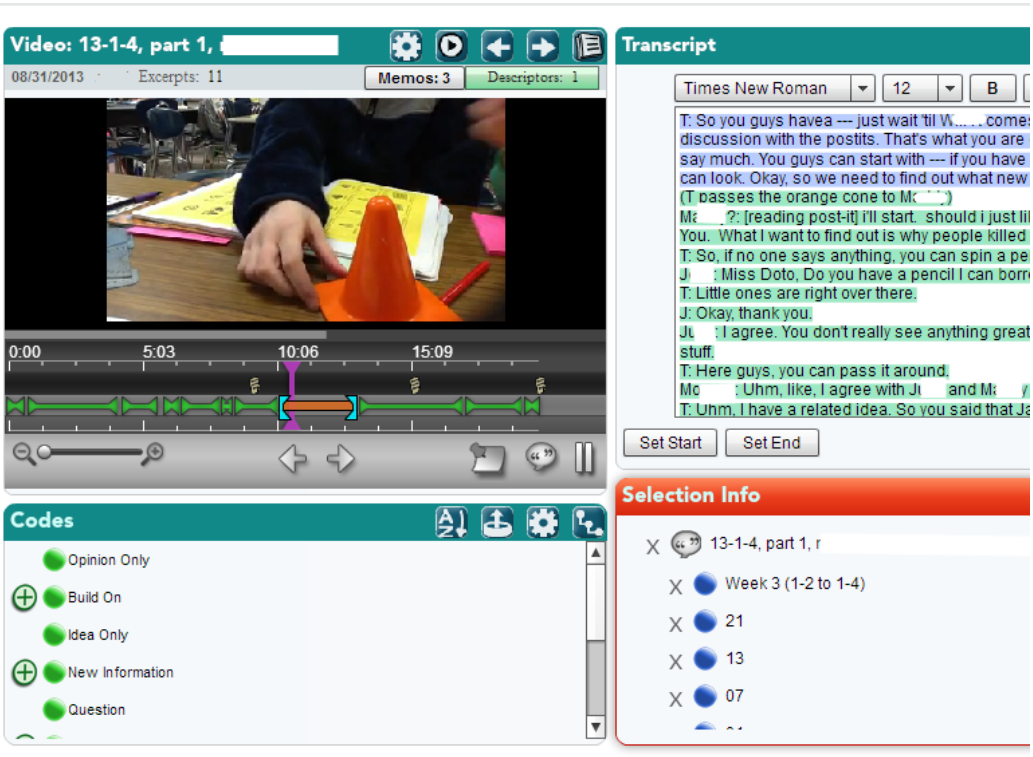


Figure 19. Screenshot of coding with Dedoose software

Excerpts ranged in length from 30 seconds to 8 minutes. The longer excerpts were primarily dialogic scaffolding during reading conferences. Shorter excerpts were usually teacher modeling or directions. This variable coding grain allowed trends to become apparent in the nature of teacher scaffolding and student discourse during conferences. This allowed children's discourse to be tracked over time. These excerpts allowed trends to be seen in conversational turns and student-teacher interactions. The student knowledge building discourse codes, along with Knowledge Forum excerpts, are outlined in Tables 9 and 10. Although the codes are identical to those of the first iteration, the tables include excerpts from the second iteration.

Developing reading conference scaffolding codes. As described in the previous section, an analysis of students' knowledge building discourse was applied to answer the question: Do knowledge building scaffolds improve discourse? However, the second purpose of this design based study was to show *how* the scaffolds improved discourse. Multiple coding grains illustrated the complexity of scaffolding during reading conferences. These codes are outlined in Tables 11 – 14. Codes emerged while viewing and analyzing 10 hours of reading conference video data. In some cases, the codes that developed were too fine a grain; therefore, the parent code was used in analysis (for example, codes about the post-it note scaffolds). In other cases, the codes that developed were a medium grain, and the codes themselves were used for analysis (for example, codes about questioning). All quantitative comparisons were made using the medium coding grain. Qualitative conclusions were also drawn from the fine coding grain (Chi, 1997).

Developing dialogic scaffolding codes. During reading conferences, the students engaged in knowledge building discourse in face-to-face interactions. A coding scheme was also developed in order to analyze the teacher's role in modeling and scaffolding knowledge building discourse. Table 11 shows how the teacher participated in the knowledge building discourse using tiered responses. Knowledge Forum codes are outlined in Tables 10 and 11; reading conference scaffolding codes are outlined in Tables 12, 13, and 14. Using the codes, reading conference discourse was analyzed to develop a trajectory for scaffolding students' knowledge building discourse.

Table 11. Teacher dialogic instruction during reading conferences

	Coarse Grain: Categories	Medium Grain: Level of Analysis	Fine Grain: Qualitative Observations	Teacher Discourse Example
DIALOGIC INSTRUCTION	New Information Teacher Discourse	Tier 3	New info with new idea New info with explanation	Electron microscopes let us see little hairs on a mosquito. And my idea, my own idea, I was trying to think why they would have fuzzy hairs, I think maybe it's to keep them warm, just like fur keeps mammals warm, but I'm not sure.
		Tier 2	New info with connection New info with question	So you guys are (pointing to food chains diagram), we are secondary consumers that eat plants and animals. What if you had a hamburger with lettuce and tomato? Right?
		Tier 1	New information only New information with opinion	On this one [post-it], I wrote "doubtful" because it talked about how we went to the moon and there are so many reasons why it may not have been possible that I don't really believe it. But that's my opinion. That's not a fact.
	Build-On Teacher Discourse	Tier 3	Related new information	What I learned is because in the rainforest there is so many plants, there are thousands of trees and it's completely covered in plants, can you guess why the soil has very little nutrients? … Yeah. It helps regular forests. But rainforests, because the soil is so poor, all the nutrients are in the plants.
			Related idea Related theory with evidence Related big idea	You know how the moon is close to the Earth and the Earth is really big? And the moon is so locked into the Earth's gravity, it goes around like this, right? [not spinning] So the sun is huge and Venus is pretty close to the sun. Venus also goes around like this. So do you have any idea that why Venus might do that as oppose to spinning around? . . . It's a theory. You could also look it up and see.
		Tier 2	Question Connection	So it's kind of like milk. It's like, it's a mixture, you know how when we put powder in water and stir, it's cloudy? It's a cloudy mixture but the particles are so small they never fall to the bottom. They just stay in there.
		Tier 1	Opinion	That's pretty awesome.

Table 12. Teacher instruction during reading conferences

Coarse Grain: Categories		Medium Grain: Level of Analysis	Teacher Discourse Examples
INSTRUCTIONAL DISCOURSE	Teaching	Directions & modeling	Okay, so. J., you are going to do the same thing here, now. If you want, you can take all these and stick them in these categories. Or do you want to do a second Venus page? So let's stop now and just go around and kind of tell about what you thought was most interesting. (Opens a book and shows it to the students.) Here, kind of like this. . . It talks about the moon goes 2,300 miles per hour around the earth and takes 27 days, and I had a question, one of the post-its on the bottom, you see, this picture? It was talking about the far side of the moon. . .
		Content knowledge	Yes, but not everything works [can form a chemical reaction] because it depends where the electrons are. They have to want each other's electrons.
		Restating big idea	So E., you said that, for your big idea, and for your evidence, you said a lot of the biggest animals eat plants, such as whales eat plankton, right?
	Questioning	Information question	R., where are they [bison] found?
		Thinking question	Can you guys think more about that? So you built on what M. said. So how does energy and particles moving fast and dissolving, how did that all have to do with each other? What do you think? That's a huge idea.
		Big ideas question	Since you are reading the same book, can we try to figure out, we can even discuss here, what are some big ideas, because you have lots of information. Did you guys figure out some big ideas based on the post-its? Maybe flip through them and read them to yourselves.
		Eliciting responses	Can you respond to E.?

Table 13. Instruction with materials during reading conferences

	Coarse Grain: Categories	Medium Grain: Level of Analysis	Teacher Discourse Examples
INSTRUCTION W/ MATERIALS	Using discussion boards	Using discussion board	Can you respond to him using something from the chart? . . .Like use something from this. [pointing to discussion board] Do you have a response for J.? . . .Now can you do your response down here? [referring to response portion of discussion board] When in doubt, you can always ask a question.
	Reading nonfiction texts	Brief question re: book	You can even tell us. What was interesting when you were reading?
		Comprehending nonfiction	So it seems like that you guys are reading the books much more slowly now, that's perfect. Let's try to get pulled into nonfiction and not to skim the parts that you learned about already.
		Picking a "just right" book	So C., does this look like a just right book, or no, that you've been reading?
		Nonfiction text features	Can you guys all read, since you read this, now just look at the pictures and captions and see if you can get any other info.
		Referring to diagrams	What do you think about that diagram? Let's show M. the diagram. . .What do you guys think about that? E., if you look at yours, do you have bacteria on top of your food chains?

Table 14. Instruction with post-it notes during reading conferences

Coarse Grain: Categories	Medium Grain: Level of Analysis	Fine Grain: Qualitative Observations	Teacher Discourse Example
INSTRUCTION WITH MATERIALS	Writing and organizing post-it notes	Writing info on post-its	Using post-it notes Bookmarking with post-its Writing info on post-its Adding more info to post-it Writing more post-its	I noticed that you were like really into the book but you were reading without your post-its or a journal. How are you remembering stuff to tell your group? Were you recording thinking at all or no? Today, I mean. . . That's great. But today you didn't do it. You just wanted to read? Okay. So since you just read, can you stop for a minute, since you are up here, and record some of the things that you found out while you were reading?
		Writing thinking on post-its	Adding own idea on post-it with only info	Yeah, do you want to write your idea on the back [of the post-it]? So does that mean that everything that we eat is alive? Can you think of something that we eat that is not alive? Can I see what you wrote?
			Prompting to write "gold" (tier 3) or "silver" (tier 2) post-it	Since we are just starting, how about let's all read the first two pages and just stop and try to write a gold medal stop and jot. Gold or silver. Do you guys have your post-its? So you can read the first two pages and see if you can write a gold.
		Reviewing & organizing post-its in journal	Rereading post-its Reading and rating post-its	I think yours is gold because you combined new info with your idea, like, how cool is that. Your new info is so specific. It talked about fig plants, quetzals, macaws, tapirs, sloths... That was new information AND an idea, which is pretty awesome. What were you thinking about [my post-it]?
			Categorizing post-its Organizing post-its in journal	SO you had "bison", "body parts", "other" and what's the other one? . . . Great. Can you do the same for all your animals? That way when you go back on Knowledge Forum you will be able to find post-its easily to share information.

Assessments of Reading Comprehension

Reading comprehension pre- and post-tests. This study also set out to show whether children could achieve literacy standards while engaging in knowledge building. Pre-tests (Appendix E) were administered to students before the start of the unit. Tests were used from to Reading A-Z (Reading A-Z, 2014), which has fiction and nonfiction texts along with multiple choice and open-ended questions. The reading level was S, which is the benchmark instructional level for the time of year (December/January) when the study occurred. A similar test (the same reading level and genre, but a different reading selection) was administered at the close of the unit (Appendix F). The multiple choice questions were scored out of 100%. The open-ended response was scored using the New Jersey state scoring rubric. Since none of the students scored 0 or 1 on the state rubric, the numbers were changed to 3, 2, and 1. Students answered two open response questions using nonfiction text, so the possible scores for open-ended responses ranged from 2 to 6.

Points	Criteria
~~4~~ 3	A 4-point response clearly demonstrates understanding of the task, completes all requirements, and provides a clear and focused explanation/opinion that links to or extends aspects of the text.
~~3~~ 2	A 3-point response demonstrates an understanding of the task, addresses all requirements, and provides some explanation/opinion using situations or ideas from the text as support.
~~2~~ 1	A 2-point response may address all of the requirements, but demonstrates a partial understanding of the task, and uses text incorrectly or with limited success resulting in an inconsistent or flawed explanation.

Figure 20. NJ Open-Ended Scoring Rubric for Reading, Listening, and Viewing

Benchmark assessments. Additionally, students' independent reading levels were assessed with reading benchmark assessments (Teachers College Reading and Writing Project, 2010). Reading levels were assessed at the beginning and end of the unit.

For each assessment, students read a short selection aloud, completed it silently, provided a retelling, and then answered literal and inferential questions orally. The reading assessments were fiction; still, even though the unit was based on informational texts, most students improved in their reading levels. The reading level data was combined with end-of-year standardized test data for a broad picture of students' literacy development.

Standardized test data. Students took the NJ ASK test as both fourth graders in 2011-2012, and fifth graders in 2012-2013. Their language arts literacy scores were available, as were those of other students in the grade. The scores demonstrated that students met language arts literacy standards while engaging in knowledge building activities.

Summary

As in the first study, sociocultural principles outlined the design of the second iteration. However, a reading workshop approach more closely aligned with the sociocultural framework of the knowledge building methodology. First, children could engage in authentic discourse with teacher guidance. Also, they could receive feedback on their independent research during reading conferences, which served as a cognitive apprenticeship. Furthermore, students were able to engage in face-to-face knowledge building discourse with a partner and research group. The results of Chapter 5 will show how knowledge building discourse improved in the second iteration as a result of these modifications.

CHAPTER 5: RESULTS OF STUDY 2

The results in this section illustrate the quality and complexity of students' knowledge building discourse based on authoritative sources during the second iteration. First, Knowledge Forum discourse was coded to analyze whether a cognitive apprenticeship during balanced literacy improved knowledge building discourse. In addition, approximately 10 hours of reading conference video data was examined to describe in detail how the cognitive apprenticeship improved discourse. Finally, tests of reading comprehension ensured that students grew as readers during knowledge building activities. These features paint a picture of knowledge building during reading instruction. Each of these data sets will be analyzed in the following sections.

Methods in Reading Instruction (Research Question 1)

This section will provide a qualitative description of discourse and activity structures during small group reading conferences. Usually, more than one student was called up to the front table for a conference. During the course of a week, between two and four conferences were scheduled daily for a total of about 40 minutes a day. During conferences, the rest of the class was also engaged in knowledge building activities. Most students read independently and took notes with their post-its and journals. Beginning in the third week of the unit, five children per day (usually a research group) posted on Knowledge Forum while the other students researched independently or conferred with the teacher.

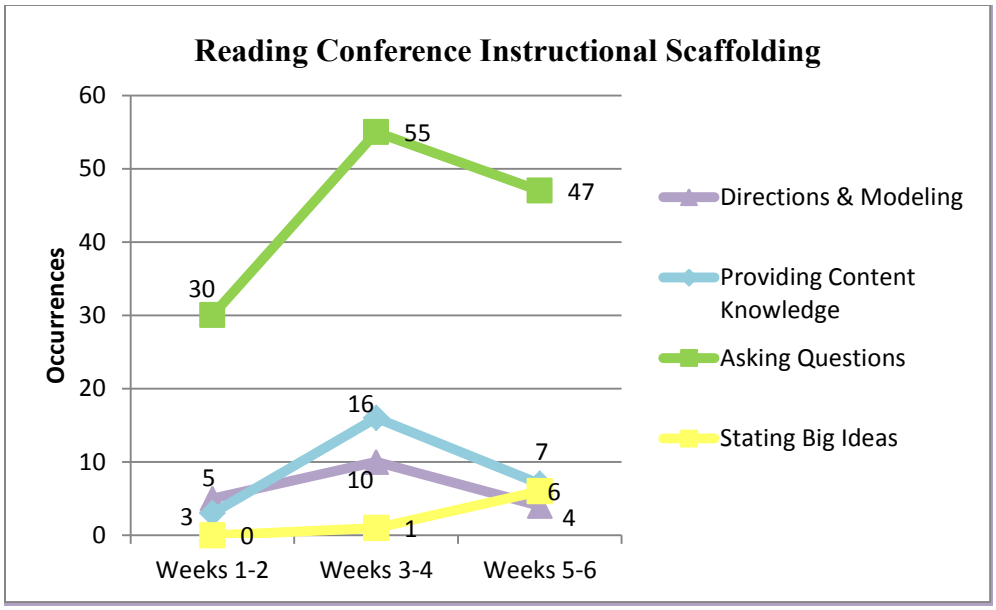


Figure 21. Instructional scaffolding during reading conferences

Instructional scaffolding. One role of the teacher during reading conferences was to provide scaffolding and instruction. Video excerpts from 10 hours of reading conferences were coded and analyzed. Questioning, being the largest component, will be examined in more detail later in a separate section. All instructional dialogue was encompassed under the codes developed during a review of the videos. Such instruction will be highlighted along with excerpts and related Knowledge Forum posts.

Directions & modeling. Often, the teacher modeled for students how to share and discuss knowledge from informational texts. For example, the teacher modeled how to introduce new ideas from books and record information on post-its. More often, directions without modeling were provided at the beginning of a reading conference to get the group started. For example, during Week 4, the following exchange prompted students to begin a discussion with their post-its, journals, and discussion boards. This led to 15 minutes of discourse about soil layers, chemical bonding, how molecules form

substances, and the particle theory of states of matter. The directions and modeling are in bold.

> **Teacher: So let's have a discussion, just like you did before. And do you remember, I'm going to open up to the discussion page. One person is going to say something and everyone else can refer to it. And if you want to keep looking through your post-its, you can keep this out (teachers copy of discussion board) so you can look through your post-its if you want.** So who has an interesting idea to start? Like a new information?
>
> M.: My new thing, there are three different layers of soil. Without one layer all the soil would be gone. And, because they kind of work together.
>
> Teacher: I have a question about the new information. What are the three layers? Do you know the names or what they are made of?
>
> M.: It was in my book. (M. flips through her journal to find a diagram she drew of soil layers, which begins the group's discussion.)

The use of directions and modeling was highest during the third and fourth weeks, when the discussion board was introduced. After that, it leveled off as students took more responsibility for beginning and maintaining their own discussions.

Providing content knowledge. In most of the instances when the teacher provided content knowledge, it was usually embedded in a discussion like the one below. In this excerpt, the teacher provided one piece of information, around which the students continued their discussion. In the excerpt below, instead of being a fact to memorize, the content knowledge was used by the students to form a new idea about revolution. Throughout the unit, content knowledge was provided about higher-level scientific concepts such as human evolution, atomic particles, and transfer of energy through food chains. Most content knowledge was provided by the teacher during the third and fourth

weeks. During the first two weeks, students were learning more basic-level knowledge, and instruction was highly focused on reading texts and writing post-its. By the fifth and sixth weeks, teacher scaffolding was centered more on generating big ideas from existing knowledge. The exchange below, during the sixth week, shows how students built ideas around teacher-provided knowledge (in bold).

O.: Maybe the sun orbits another star.
Teacher: It does orbit the center of the galaxy.
(pause of silence)
T.: Whoa.
Teacher: Did you guys come across that yet?
Multiple Students: No.
J.: I was going to say that the sun orbited a bigger sun.
W.: Why does everything orbit the sun?
Teacher: That's a big idea.
W.: Yeah.
T.: Like the Earth orbits the sun, the moon orbits the Earth and the sun orbits the galaxy.
J.: What does our universe orbit?
W.: And the galaxy orbits the . . .
Teacher: We don't know.
T.: The galaxy orbits the universe.
Teacher: Maybe, if there's anything bigger we don't know about it.
J.: The universe orbits the universe.
T.: So, all of a sudden we're all going in a bit swirl.

During the exchange above, all four students from the planets group had their books, journals, and post-its at the front table. In addition, the group drew on their knowledge of orbits, posted previously on Knowledge Forum, to generate the ideas above. For example, this note by W. had been posted during the previous week:

the moon orbits

The moon orbits the Earth like the Earth orbits the sun. It takes the moon 27 days for the moon to orbit the Earth once. It takes the Earth 365 days to orbit the sun. It takes the moon 27 days to spin on its axis it take the Earth 24 hours to spin on it's axis. I think the moon's orbit is shorter because it has less space to travel.

Figure 22. Knowledge Forum post from planets view

During the previous week, two of the other students above had also discussed orbits during a reading conference. They researched a book together with along with the teacher. M. had been reading the book on his own throughout the week, and he frequently discussed its diagrams with members of his group. As seen in Figure 23 and the excerpt below, the students were prompted to read the captions to see how dents in space-time created orbits. After reading the books and captions, they understood about orbits, but still did not quite see how orbits were created by gravity.

Teacher: Oh, what's that? Did you read about that?

M.: Those are the orbits.

J.: This is Mercury, then you have Venus over here, then you've got Earth. And then also, somewhere over there, you can find Mars.

Teacher: And there's something also very important about these lines. Did you read the captions?

Figure 23. Shared reading of book diagram during discussion about orbits

At the time, the two students did not make a connection between dents in space-time, gravity, and orbits. However, after the reading conference, M. built upon this book to later post the following note on Knowledge Forum.

Black Holes

Black holes are the most powerful thing ever known to man kind. They are very hard to identify because our radio waves don't get specific signal from them. We just know because the objects around them are having strange signals that tells how there might be something around that area. Our sun makes a small dent in space where things can travel at normal speeds and get past; a white dwarf star makes a larger dent that could only be past at e very fast speed. Neutron stars make a very large dent with very steep sides that could only be past at half the speed of light or faster. Now black holes make such a large dent that is so steep that not even light can escape.

Figure 24. Knowledge Forum post from planets view

This Knowledge Forum post demonstrates the advanced level of knowledge that the group had reached with dialogic scaffolding. Teacher scaffolding during reading conferences allowed students to build concepts, such as orbits and gravity, over the course of weeks. Another useful scaffold was discussing "big ideas" with students.

Discussing big ideas. This leads into the synthesis of big ideas. As students generated knowledge, the teacher began to help them see connections and overarching concepts in what they were learning. For this reason, as shown in Figure 21 on page 94, discussion of big ideas increased over time. Below is an excerpt from week 6, in which the teacher simply lets a student know that she had discovered a big, overarching idea. In this excerpt, the teacher was meeting with a student who had been researching about ocean and grassland food chains. During the exchange, the student referred to her post-its and journal, as can be seen in Figure 25.

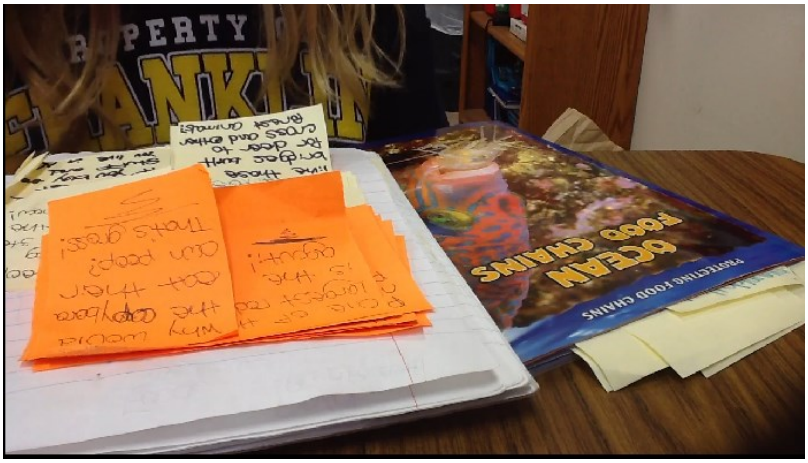


Figure 25. Student referring to post-its and journals during reading conference

Teacher: What's interesting about the ocean food chain?

E.: A lot of times, people think the bigger fish prey on the big animals. But really they don't. Um, they prey on, like, the plankton. Most of whales actually prey on the zooplankton. You know the whales are bigger so they like, feed on the plankton. And also, even though it's like the smallest little thing, if the zooplankton were gone, a lot of fish depend on the zooplankton, so not a lot of fish would live. And also, if there's no phytoplankton, again that would affect the food chain in a big way.

Teacher: That's interesting. **So I noticed, not only do you have evidence, but you came up with a whole 'nother big idea. I just realized, I had never thought of it before. So E., you said that, for your big idea, and for your evidence, you said a lot of the biggest animals eat plants, such as whales eat plankton, right?** Can you write that here (in your journal) as evidence?

During the following week, E. also posted a related note on Knowledge Forum.

Samllest animals make a difference

I found out that in the ocean food chains book that even the biggest animals in the ocean like whales, depend on the smaller animals because sometimes that is all they eat! For example: Whales eat krill and some other plankton. Krill and plankton are small, but make a huge difference to the food chains. So I think, even the smallest is huge in their own way.

Support: My idea

Figure 26. Knowledge Forum post from food chains view

The excerpts discussed in this section summarize the teacher's use of directions and modeling, providing content knowledge, and restating big ideas. However, most of the dialogic instruction was done through the use of questioning. These questions will be discussed in more detail in the next section.

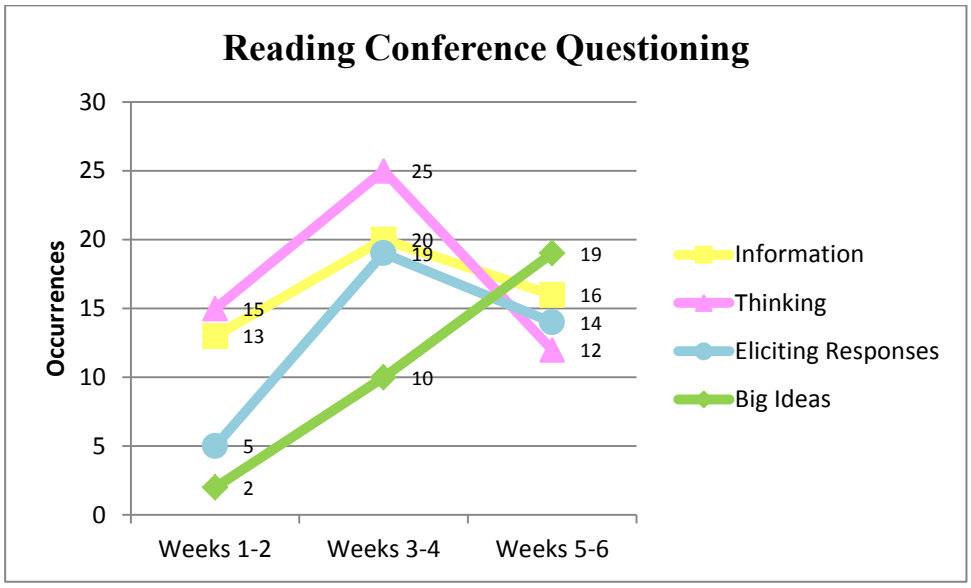


Figure 27. Teacher questioning during reading conferences

Teacher questioning. The majority of interactions with students during reading conferences consisted of questions. Furthermore, the questioning was categorized into four overarching types showing in Figure 27. First, I asked students questions about information they had researched in their books or written on their post-its. These were coded as "Information" questions. Frequently, I asked students questions about their own ideas, which were coded as "Thinking" questions. "Eliciting Responses", or asking for students to respond to new information, were questions used to keep discussions going. Finally, throughout the unit, I asked students to generate "Big Ideas" based on knowledge. These four types of questions, along with examples, will be examined in

more detail below. Also, it can be seen from the excerpts that a combination of these question types were frequently used during one reading conference.

Figure 27 shows a number of instructional trends. First, questions about big ideas increased over time. Also, eliciting responses peaked in the second week when students were beginning dialogic instruction, and then the scaffold was removed as they took responsibility for their own discussions. Questions about thinking and information also increased from the beginning to middle of the unit, as students became familiar with writing "gold" (tier 3) and "silver" (tier 2) post-its. Finally, much of the instruction during the first week was with writing post-its and strategy instruction, rather than dialogic questioning. Towards the end of the unit, students took more responsibility for leading their own discussions. In the sections below, I will examine each question type, as well as how they scaffolded students' knowledge building discourse.

Questions about information. Often, I simply asked students about information. These questions might be related to books or students' post-its. It was useful to ask about information when students were skimming books, or if they did not record specific new information on stop & jots (post-its). The exchange below occurred during a conference when children were writing and sharing post-its.

> **Teacher: R., what new information did you find on peacocks?** You guys are really good at stop and jots. You guys get lots of information.
>
> R.: There are three species of the peafowl. There is the Congo, the Green and the Indian peafowl. The scientific names for them is the (sounding out slowly) Pavo cristatus.
>
> Teacher: I never knew that. That's really new information. Wow, did you have an idea about that? Right now, it's bronze 'cause it's right in the book, but what is your idea about it? What were you thinking as you read?
>
> (R. adds to her post-it.)

As can be seen in this excerpt, questions were rarely limited to information, but were often combined with inquiries about students' thinking. As the weeks progressed, more questions were in reference to students' thinking and concepts about information.

Questions about thinking. Frequently, questioning prompted students to rise above a text, discussing their ideas about information. This often came in the form of prompts to add what they thought about information, as in the excerpt above. At other times, questions about thinking led the discussion. For example, the questions "What do you think?" in the excerpt below prompted students to discuss molecules in solids, liquids, and gases. First, S. introduced new information. By getting the students to think about the information, they began building knowledge about states of matter.

S.: Heating a liquid gives the particles more energy to move around.

Teacher: **What do you guys think?** Let's look at your discussion boards. Here S., you can hand [the talking cone] over.

M.: I think that what we learned in science was like, when you heat water, it dissolves quicker.

E.: I heard somewhere that ...

Teacher: Are you responding to M.?

E.: Yeah. When you heat water, water turns into gas and gas it moves freely, so they start moving faster and they transform into gases.

Teacher: **Can you guys think more about that?** So you built on what M. said. So how does energy and particles moving fast and dissolving, how did that all have to do with each other? **What do you think?** That's a huge idea.

S.: I know, I think, well I know, by this (pointing to journal) I know why snow melts, like if you eat snow, I guess the particles move around I guess that makes it like a liquid.

Teacher: Oh, kind of like that chart over there? [pointing to poster of atoms in solids, liquids, and gases]

E.: Solids are packed together and liquids move around and gases are just all over the place.

In addition to questions about information and thinking, the most advanced questioning type was about big ideas. “Big ideas” were overarching concepts synthesized from knowledge over time. In the example above, the teacher referred to the big idea of temperature. It can be seen in Figure 27 that questions about big ideas increased over time. This will be discussed in more detail below.

Questions about big ideas. As a situated participant, I found it most difficult to ask questions about big ideas. These were difficult questions for students to answer, and at times I felt as though I should let them continue researching information. However, in hindsight, after looking at the video and Knowledge Forum discourse, these questions allowed students to generate new concepts from their research. Many big ideas, such as elements created in stars, were not discussed independently by students in Knowledge Forum. However, the excerpt below shows how students used instructional scaffolding, along with text sources and Knowledge Forum discourse, to discuss transfer of energy and nutrients in food chains.

> **Teacher: Since you are reading the same book, can we try to figure out, we can even discuss here, what are some big ideas, because you have lots of information. Did you guys figure out some big ideas based on the post-its?** Maybe flip through them and read them to yourselves.
>
> E.: Some of the big ideas are different groups of animals, like different groups of the food chains, like decomposers and producers and secondary consumers and primary consumers. Like a lot of those (flipping through book looking at post-its).
>
> Teacher: Can you respond to E.?
>
> S.: I think they're all really important, because the decomposers are like, they are the ones that make the circle go on, and they need to complete it. So then, it just starts like over again. On Knowledge Forum, they like were talking about rainforest food chains, like how soil doesn't have any nutrients. . . so I was wondering, does it mean

> the soil is dry? And I was wondering if decomposers get all their energy from the dead animals and plants, so they could bring it all to the soil. So I don't know about that.

In the excerpt above, a student referred to Knowledge Forum discourse when generating a big idea. Reading conference discussions often scaffolded students' knowledge building, so that their ideas later showed up as Knowledge Forum posts. This will be examined in the next section.

Supporting independent knowledge building. As can be seen in the previous sections, discussions and information from conferences often showed up as students' independent knowledge building discourse within Knowledge Forum. A total of eight reading conference topics were later found directly within Knowledge Forum. Some examples were the Sun's gravity, predators, endangered animals, and the history of art. Knowledge Forum was where the students built knowledge independently, and reading conferences were where they could build knowledge with instructional scaffolding. The excerpt below shows an example of knowledge growing over time. First, an idea was presented on January 3, during a reading conference when E. read aloud her post-it about a type of butterfly with camouflage.

> Teacher: So, so far everything you guys are saying relates to all animals right? So what can you summarize everything as?
>
> E.: Everyone- every animal can have certain adaptations to help them survive.
>
> M.: Every animal's different.
>
> Teacher: Different but related, right? Is there any other new info that's interesting that you guys want to discuss?
>
> (M. is looking through the book and E. is reading her post it notes)
>
> **E.: I just have another adaptation type thing. It said that a blue morpho butterfly**

has wings that are brown on one side and blue on the other side. So, I think that maybe that, um, they use that to camouflage. Um, so maybe that's like one of their adaptations.

M.: I have, um, a text to text connection cause I remember reading a book and it said that some butterflies have like, on the back of their wings, they're like these circles and they're eyes so that they can see behind them.

Teacher: You reminded me of another text to text that some butterflies, these butterflies they were mostly white with black spots but then, like in the 1800's when factories started producing a lot of smoke and soot covered everything and trees were black, the butterflies started turning black with white spots. So maybe they are adapting for some reason, there's something blue where they can hide.

In the reading conference above, both the teacher and M. demonstrated misconceptions while building knowledge. M. thought that the eyes on the backs of butterflies for camouflage could "see behind them". During the conference, the teacher thought about what could be blue that the butterflies were camouflaged against. Two weeks later, E. had generated a theory in which she summarized a possible reason for the butterfly's coloring (in bold). This knowledge was built over two weeks with a book, three students, and teacher scaffolding. Throughout the course of the unit, many ideas that were introduced in conferences later appeared within Knowledge Forum.

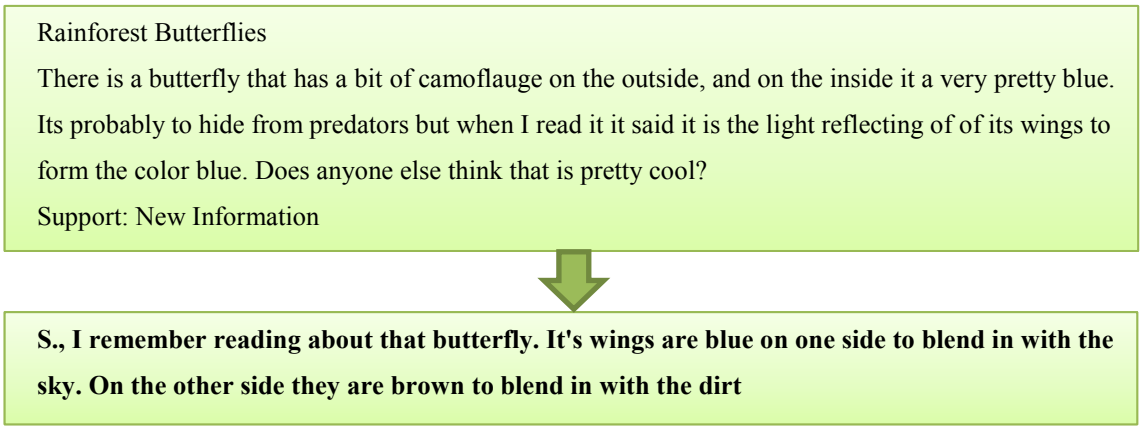


Figure 28. Knowledge Forum posts from food chains view

Scaffolding comprehension of informational texts. Another component of reading conferences was the scaffolding of informational texts. After reviewing the reading conference video data, it became apparent that this scaffolding consisted of the categories in Figure 29 below. At times, I asked a brief question about students' books, even though we worked primarily with post-its and journals. At other times, I spoke with children about picking books on their reading level. In some instances, we discussed how to read nonfiction texts. However, instruction primarily occurred with nonfiction text features and diagrams. Most of the work with diagrams occurred during the third and fourth weeks. In this way, students worked with informational text during knowledge building.

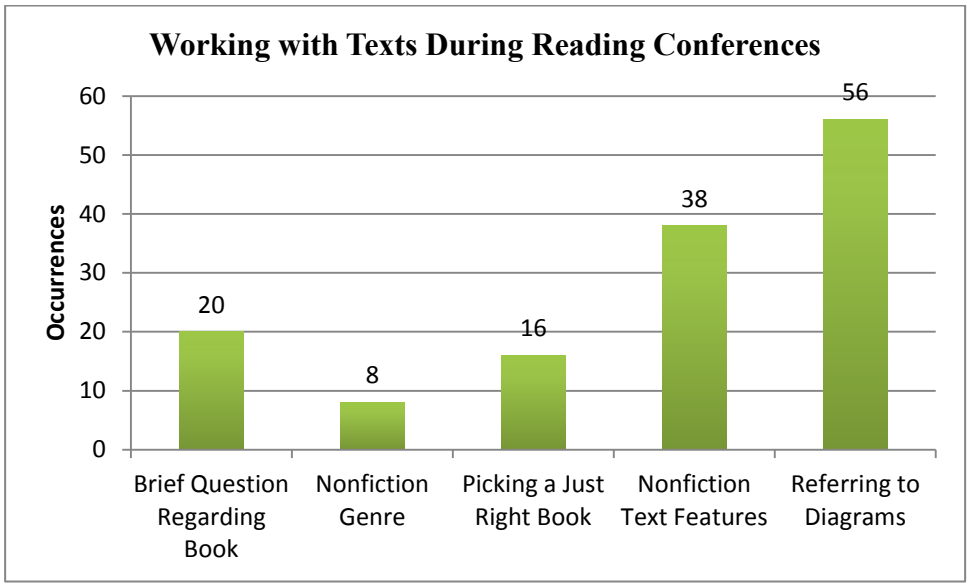


Figure 29. Scaffolding of nonfiction texts during reading conferences

Brief questions regarding books. In some cases, a question served to draw books into the reading conference along with post-its and journals. In these instances, there was

little interaction with the book, just a quick check to see what the students were reading. For example, the excerpt below illustrates an example of this type of exchange (in bold).

> Teacher: **So how much did you read so far in that book?**
>
> C.: I've read about maybe one third.
>
> Teacher: Wow, so you've already read one third and you don't have any stop-and-jots yet? Why don't you skim the first third and see if you remember any interesting information that you want to share with the group.

Such questions helped to keep track of the books that students were reading, as well as the progress of their research. However, other strategies provided more support during reading conferences.

Scaffolding nonfiction genre. Sometimes, it became apparent that children were not reading nonfiction for meaning. Sometimes, they skimmed text. At other times, they looked at pictures or went through books too quickly. In these cases, we discussed specific strategies for making sense of nonfiction text. For example, in the excerpt below, students were reading their books and writing a post-it during a reading conference. One student turned the page of her book very quickly.

> Teacher: I noticed you just turned the page really fast. Are you skimming or reading?
>
> M.: Well, I skimmed that part but I read that part.
>
> Teacher: You know how you read really, really slowly in fiction? You do the same thing with nonfiction. Just get into it, let it pull you in. So why don't you start over and actually read that page? Because usually the first page has all of the information and you are going to need that.
>
> J.: The only problem with reading this book and those books (two different food chains series) is because they like talk about the same things. Like they talk about like life in the mountains, and the forests or grasslands.
>
> Teacher: So when you see something that's repeated you skim? Well, believe it or not, it's

not a problem. It's a good thing. When you research, whenever I research something, the more sources I have the better, because why do you think? Why do you think it's good to have lots of sources?

M.: Maybe one books says something and the other books says another thing. You can keep looking and find out which one is right.

Teacher: Yes. Anytime, as you get older in middle school, you are never going to be able to do a report with just one book. So if you see something that's the same, that's actually the time to pay closer attention to see if you notice any new things or differences. So it's okay if you read things twice. It's actually better to read things twice. So can you read this maybe and see if there is anything different from the other book?

After the exchange above, these two students spent more time with each nonfiction book. Also, conferences provided scaffolding for children in picking books that were at or near their independent reading level.

Picking a just right book. Sometimes, children chose books that were challenging for them to read. When I noticed this, it was helpful to guide them in picking a book that was a better fit for them to read independently. In the exchange below, the student decided to switch books after being prompted to examine the book she had chosen. After this exchange, she picked a different book at her independent reading level from the classroom library.

Teacher: So R., since you just picked that book, can you look at it? Let's see if it looks just right.

R.: There's no letter in it (looking for guided reading level letter on back inside cover).

Teacher: Okay, then how else can we choose if it's just right? What do you think?

R.: If you look at all the words.

Teacher: Okay, if you look at the words. Alright, what's another method? Can you guys see the poster [anchor chart] from there? Okay, so what else?

R.: Find if you're familiar with the topic?

Teacher: Oh, do you know anything about the Salem Witch trials? So this might be kind of a tough book. How about, why don't you open it up and read the first page and see if it pulls you in.

(R. reads for some time.)

R.: I think I'll pick a different book.

Teacher: Good idea.

Even when students had chosen "just right" books, they often needed assistance with the use of nonfiction text features. Scaffolding use of text features was a major component of reading conferences.

Working with text features. During conferences, students sometimes ignored features of nonfiction texts. Scaffolding included prompts to read and discuss captions to understand diagrams. At other times, children looked up bold words in the glossary. We used the index and table of contents to find information. Children also learned how paragraphs described nearby diagrams. The excerpt below shows how a student was prompted to read a caption and use the glossary in order to make sense of a diagram. The excerpt below shows an example of teaching nonfiction text features and referring to diagrams.

Teacher: What is that?

J.: I think it's like a star diagram like kind of dying.

Teacher: Did you read the caption on that one?

J.: Yeah.

Teacher: Read it one more time and see if you can figure out what that is. (J. reads caption silently.) So what is that?

J.: It's like a (sounding out) planet-ary neb-ula.

Teacher: Yeah, planetary nebula. If you look down there, see how it's bold? So if you flip back to the glossary you will see what that is. It's actually a really important new information that you can probably share with everyone. So J., what is a planetary

nebula? (looking at picture in book)

J.: I think it's, it's kind of like, it's like dust that comes out, um ...

Teacher: Let's see, what did the glossary say?

J.: Um, (reading glossary) it says a cloud of gas and dust in space. New stars are made in some nebula.

Teacher: So basically, yeah, it's a cloud of dust and that cloud causes, that's where our solar system came from too. So if you look at that, that's what we think. If you look at that picture, that's like, eventually that will turn into a sun with planets around it when they come together.

J.: Oh. (laughs)

Teacher: It's like the birth of solar systems. So can you like write new information about that so you can share that with the group? I don't know if anyone discovered that yet. That's really interesting.

J.: Sure, okay. (begins writing post-it)

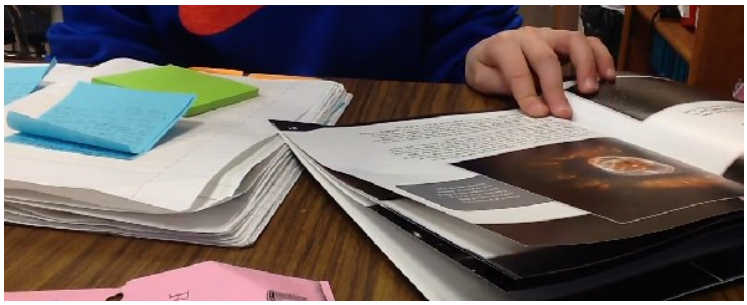


Figure 30. Student reading caption about diagram of planetary nebula

When reading the book without scaffolding, J. had not been sure what a planetary nebula was. After scaffolding with captions, the glossary, and teacher-provided content knowledge, J. posted a note on Knowledge Forum the following day. Previously, J. had been talking about how stars do not really have points, but instead are made of gases. He was able to relate this to the information discussed at the conference, and also posted a note about stars being made of gases the following day. The note shows a beginning understanding of the concept.

Nebula J.
I learned that Nebua (a cloud of gas and dust in space) is the thing that can start up solar systems. I have a prediction that something like Nebula started up our solar system. I also think that our planet was made up of dust from something like Nebula.I also wounder if every major star has a solar system made up of something like Nebula.
Support: New Information

Figure 31. Knowledge Forum post from planets view

Referring to pictures or diagrams. As can be seen in the previous excerpt, working with diagrams occurred many times along with other aspects of reading conferences. In the history group, we looked at and discussed diagrams of castles, armor, and maps. The chemistry group made sense of atomic diagrams. The planets groups looked at models of the solar system. The food chains group often discussed the food chains diagrams found in their books. The excerpt below illustrates a student who is prompted to compare diagrams between two books in order to interpret information.

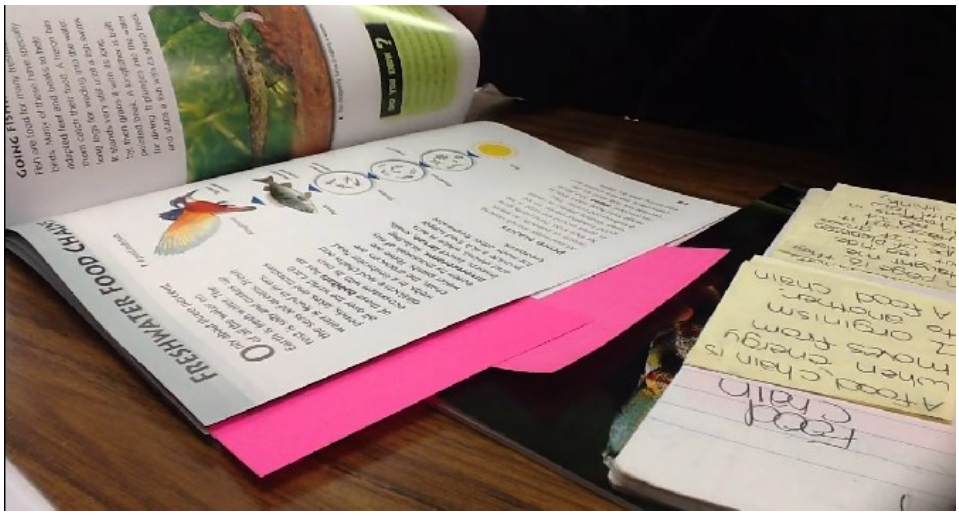


Figure 32. Student viewing a diagram of a food chain

Teacher: That's an interesting diagram. How is that different than the ones from the other book? Or is it the same?

M.: (pointing to food chains diagram) Well because it sort of started with the sun.

Teacher: Is that the same or different?

M.: Different, and it ended with that and not the decomposer.

Teacher: Oh, so which book do you think is more accurate?

M.: The other book.

Teacher: How come?

M.: Because it said that everything has to have a decomposer at the end. And so, this one doesn't have any. That one doesn't have a decomposer either.

Teacher: Oh, that's interesting. So do you see why it's good to have multiple sources?

The Sun and decomposers as the beginning and ending of food chains became a major theme on Knowledge Forum. Reading conferences were invaluable in scaffolding knowledge building. They allowed students to use instructional materials with teacher support. They also provided a space where students could practice knowledge building with their post-its and books using dialogic scaffolds. These dialogic scaffolds will be examined in the next section.

Instructional Scaffolds (Research Question 2)

Instructional Materials

During reading conferences, instructional materials also helped to make thinking visible (Rogoff, 1990). During each conference, students brought their research books, post-its, and journal to the front table. Beginning in the third week, students also had a discussion board pasted into their journals. As can be seen in Figure 33, a number of trends are apparent. At the beginning of the unit, reading conferences focused on recording information from texts on post-its. Along with information, children were also prompted to record their thinking about texts. During the middle of the unit, much time

was spent organizing their research post-its into categories. Also, children discussed this research using discussion boards. Toward the end of the unit, children took more initiative for leading and maintaining their own discussions.

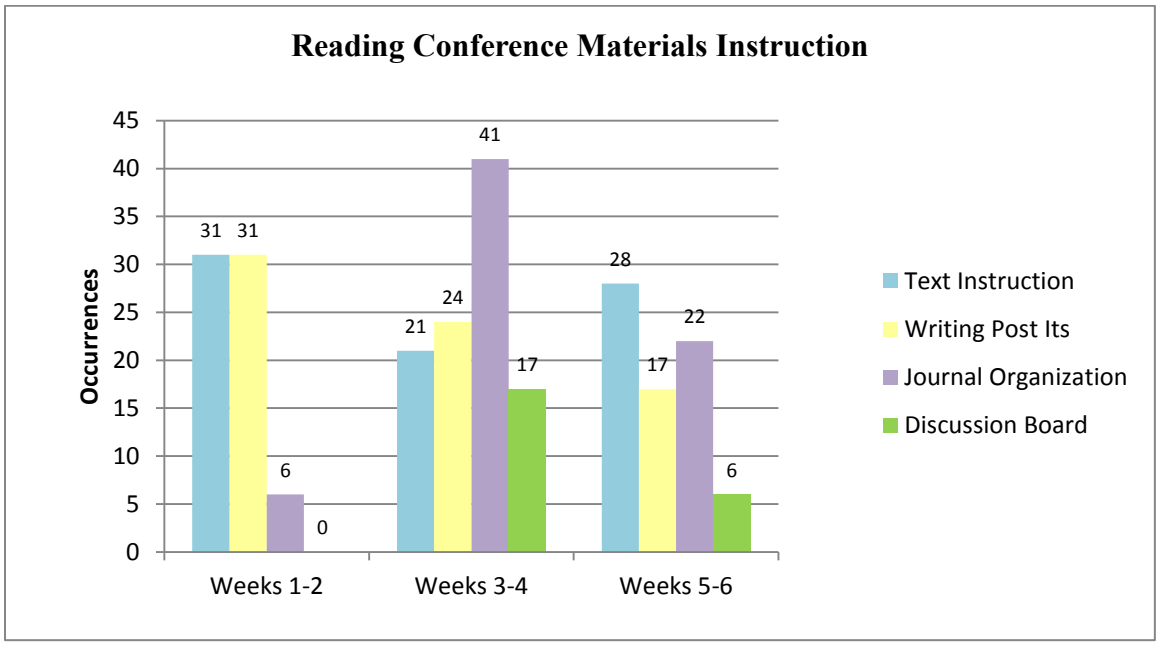


Figure 33. Teacher instruction with materials during reading conferences

Recording and organizing information. In Reading Workshop, students can record their thinking and evidence about texts on post-its (Calkins, 2011). Many students, including the participants in this study, are familiar with recording their ideas on sticky notes during reading. The notes, first stuck into books near related text, can later be removed and organized based on bigger ideas. During the knowledge building unit, students learned how to record their evidence and ideas on post-it notes. Upon finishing a book, they were prompted to remove the notes and organize them in their reading journals. One student even came up with a term for taking post-its out of a book: "de-post-it-ing". These sticky notes became the basis for most Knowledge Forum notes that

were later posted by students. As can be seen in Figure 34, instruction with post-its changed over time. The first two weeks focused heavily on recording information, and the following weeks stressed organizing concepts and ideas.

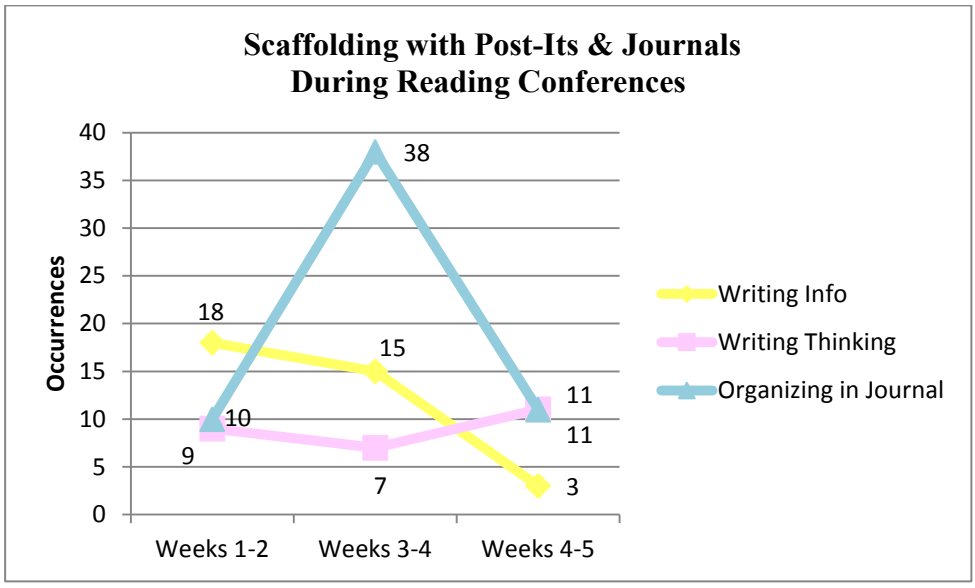


Figure 34. Trajectory for scaffolding use of post-its during knowledge building

Writing information on sticky notes. In the beginning stages of the knowledge building unit, I often prompted students to write information on post-its. This familiarized them with writing independently. For example, we would often read a few pages of a book, write post-its, and then read the post-its aloud. In the conference below, after a discussion about books, the students were prompted to read their individual books and record information. They had already been presented with a minilesson on writing gold, silver, and bronze post-its, and an anchor chart with examples hung in the classroom.

Teacher: Okay. Let's open up to the first page [of your books]. Since we are just starting, how about let's all read the first two pages and just stop and try to write a gold medal

stop and jot. Gold or silver. Do you guys have your post-its? So you can read the first two pages and see if you can write a gold. (Students read their books. The teacher and E. each write something down on a post-it.)

Prompting students to write information was done more frequently at the beginning of the unit, although it remained important throughout the study. Many times, this occurred with students who were reluctant to take notes on information independently. With a few reluctant note takers, I instead modeled how to take notes in their reading journals. These exchanges were not coded in the graph above. In addition to writing information, students were also prompted to write their thinking about texts.

Writing thinking on sticky notes. As students became more adept at recording information, I began to prompt them to add their own ideas to the post-its already containing information. Later, this made it easier for them to share their ideas about information on Knowledge Forum. For example, in this exchange during the fourth week, I prompted a student to add her own ideas to a sticky note containing information only.

Teacher: ...So what are some of, can you read some of the post-its to us that you...

M.: A yellowfin goatfish digs sand to catch a crab and swallow it whole. And a shark comes in and eats the yellowfin goatfish.

Teacher: Well, that's all information. Can you think about for a second about what is your idea on it, and put your idea on the back? (M. writes her idea on back of post-it.)And M., what was your idea?

M.: I thought that it keeps going on and on because it's a process. Like the food chain is just like that (pointing to diagram in book). This animal eats that and then the shark comes in and eats this animal.

Once the student had a chance to record her idea about the information, she was able to relate the knowledge to a bigger process. By bringing their information and ideas to Knowledge Forum, students were able to improve their knowledge building discourse. Two weeks after the exchange above, this same student posted a related note on Knowledge Forum containing evidence about the fish and crab. Although she demonstrates some misconceptions (such as the Sun getting energy from photosynthesis), she had developed advanced ideas about food chains over time:

Food Chain

(New Information) Animals depend on each other. They depend on each other for survival. For example: Lions depend on Zeebras for food and survival. Also, humpback whales eat zooplanktons for survival. **Also, Yellow stone goat fish eats crabs and depend on them for survival.** I depend on food and water for survival. This is why there is a food chain. Every food chain begins with the sun, which plants get energy from. The sun gets energy from photosynthesis. What ever animal that eats the plant will get energy from it. If one thing happens to the food chain,(like if a species become extinct) the whole food chain gets messed up. When a plant or animal dies it still contains energy and nutrients. Just like if people cut down to many trees, then we wont have as much oxygen. I think every animal eats something so it wont die. I think thats why there is such thing as a food chain. So every one and every thing has something to eat and drink.

Figure 35. Knowledge Forum post from food chains view

Categorizing and reviewing sticky notes. After a couple of weeks, students' books and journals were overflowing with sticky notes. The next set of minilessons and conferences instructed them to organize the post-its in their reading journals. I modeled for students how to draw boxes on journal pages in order to divide them into broad categories. Then, students placed sticky notes into categories to develop concepts based on knowledge. Some students used one page for each book they read; others placed notes from multiple books into overarching categories. During conferences, we also rated

sticky notes as gold, silver, or bronze. The majority of conferences during the third and fourth weeks were focused on organizing post-its in journals.

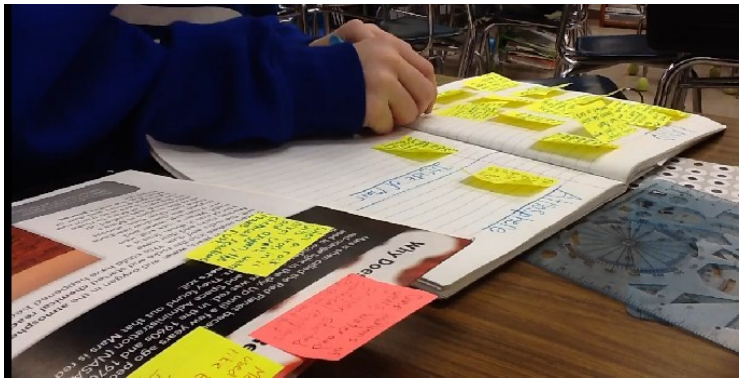


Figure 36. Student organizing post-its into categories during reading conference

Teacher: So, J., can you kind of explain to M. what you are doing when he comes back?

J: [to M.] What we are doing is what kind of categories for our post-its, like I did discoveries, like I didn't know that Mars had volcanoes and dried up river beds (reading from post-it). So you can get a clean page and write something on the top, for a category, like I was going to do ice caps because I had a lot on them.

Teacher: Because M., when we had our discussion, you had so many ideas. But you don't want to bring your book back to Knowledge Forum, you actually want to bring your notes back. Okay. So why don't you, um, do you have any ideas about the categories before you start reading?

M.: Discoveries.

Teacher: Okay, so you can do the same thing. (M. begins writing) [To J.] You have so many ideas, it's just a matter of categorizing them. What about atmosphere and land? Can you do one for atmosphere and one for land?

This trajectory arose naturally during the design based study, as a way to help children to develop ideas over time. By categorizing post-its, they were able to develop larger concepts based on multiple texts. First, they looked for information in text sources. Next, they thought about the information, connecting it to their own lives and other

sources. Finally, they organized their information and ideas into bigger concepts. Each student kept their reading journal, which became a record of their own personal knowledge building. By bringing the journal to Knowledge Forum when posting notes, children were able to build knowledge as a learning community.

Using discussion boards. Upon a preliminary viewing of the videos, after the first two weeks of the unit, I realized that I was doing most of the talking during conferences. When I asked questions, there were often long pauses during which students did not respond. To fill in the silence, I often continued speaking. In response, I created a discussion board that students pasted into their journals. They used this discussion board during reading conferences and when meeting to talk in groups. The top part of the discussion board had boxes for "New Information", "Idea + Evidence", and "Discuss Picture or Diagram". The bottom, or build-on, portion mentioned connections, questions, related new ideas, and related new information. Each box was similar to a scaffold found within Knowledge Forum. By using the discussion boards, children became familiar with engaging in knowledge building discourse. For turn-taking during discourse, students put their hand in the middle of the table if they wished to respond. The speaker then passed the "speaking cone" to a different student.

Figure 37. Discussion board in reading conference (left) and group meeting (right)

In the excerpt below, I mentioned the discussion board, and then students held a discussion during a conference. One student began the discussion by looking through his post-its to discuss new information. After that, others volunteered to share and discuss related information. The new information scaffold prompted students to look through their research for detailed information, and the build-on scaffolds prompted students to stay on topic. As can be seen below, use of the discussion board often improved the length and content of student discourse. Albeit with some misconceptions, the students went on to discuss the life cycle of our Sun (a high school level science standard).

J.: I learned that there are one hundred billion stars in our galaxy, and that there are about one hundred billion galaxies in the universe. And, um, I wonder why all of our stars are like yellow or like whitish kind of, like I guess it comes from what we can see. And, um, I wondered why the sun was such a big and hot star. Like, why it was so much bigger than the others, and um, I think that without stars we wouldn't be able to see, um, in the day because uh, we use the sun to see, and uh, like during the day. And uh, at night we use the stars and the moon. And, uh, I have a connection because um, I heard that like the reason that the moon is white is cause the sun kind of reflects onto it and then it gives it color. And that like, at night, the other half of the moon that we can't see is actually pitch black.

Teacher: That's interesting. Now, I'm not going to respond, can you guys look at your response charts and see if you have a response. You can just put your hand in the middle. So J., you can just pass the - okay.(J. passes the cone to M.)

M.: I think that the sun is so big compared to the others because it's the closest one. It's about 93 million miles away from the earth. And the closest star that isn't the sun is about like, 93 billion miles. So it's much bigger and I agree that we definitely use stars to see and um, the color of the star actually depends on the age.

J.: Oh.

M.: Like when a star is about to die it′s really big and sometimes it's like, blue and white. Am um, our sun is about middle age so it's like, red.

The quality of the students' and teacher's knowledge building discourse improved with the introduction of the discussion board. As a situated participant, I found that the discussion board helped to 1) guide student discourse, and 2) make it easier to model correct discourse when speaking with students. Both of these aspects will be discussed in the following section.

Knowledge Building Discourse (Research Question 3)

This section examines how the instructional design improved knowledge building discourse on Knowledge Forum. First, the face-to-face knowledge building discourse during reading conferences will be analyzed. Next, analysis will show that the discourse of the second iteration was more extensive and of higher quality than that of the first iteration. In addition, I will look at how students used scaffolds embedded in Knowledge Forum to build their knowledge throughout the unit. Also, a close examination of research groups within the second iteration will highlight features of successful knowledge building. Finally, I will show how the fifth graders' Knowledge Forum notes accessed middle and high school science content standards.

Knowledge Building Discourse during Reading Conferences

The same coding scheme was also used to analyze students' knowledge building discourse in both reading conferences and on Knowledge Forum. All of the scaffolds described in the reading conference sections helped the children to engage in knowledge building discourse around text sources.

Student discourse. Students also engaged in knowledge building discourse during reading conferences. This includes "new information", or a thread starter (in this case, a discussion starter); and "build-ons", or responses. The quality of discourse was

analyzed using tiers in the same method as was Knowledge Forum discourse. Knowledge Forum discourse during conferences was coded as "new information" if a child began a new topic. New information was most often introduced by reading aloud or consulting a post-it note; however, sometimes it came directly from nonfiction texts. Students also built onto new information by responding to someone else. In Figure 38, it is apparent that students contributed many topics and ideas to reading conference discourse. In face-to-face discussions, they used more Tier 2 and 3 responses when building-on to others ideas, rather than when introducing new information.

Teacher discourse. By engaging in knowledge building discourse with the students, I was able to 1) model dialogue, and 2) provide additional content knowledge. As can be seen by comparing Figures 49 and 50, students were responsible for the majority of the knowledge building discourse. The scale is the same in both figures for comparison.

Teacher new information. The (almost empty) graph in Figure 39 serves to illustrate how the content of the discussions and conferences was driven by the students and their research. The teacher provided very little new information to students, with only 8 occurrences over the course of six weeks. These included introducing new information with my opinion (Tier 1) twice, with a connection or question (Tier 2) three times, and with an idea or explanation three times. The teacher served as a guide, offering content knowledge where needed, and the students led the topics and began the discussions. In the first weeks, the teacher may have begun with some information, but later on children took complete responsibility.

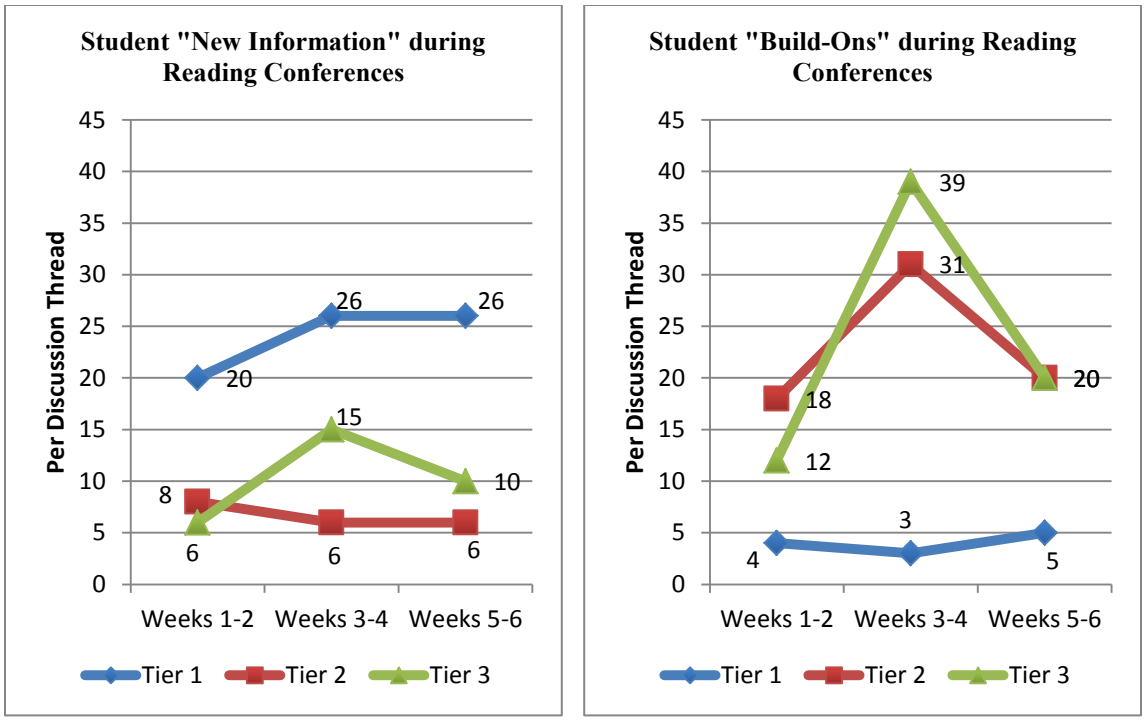


Figure 38. Student knowledge building discourse during reading conferences

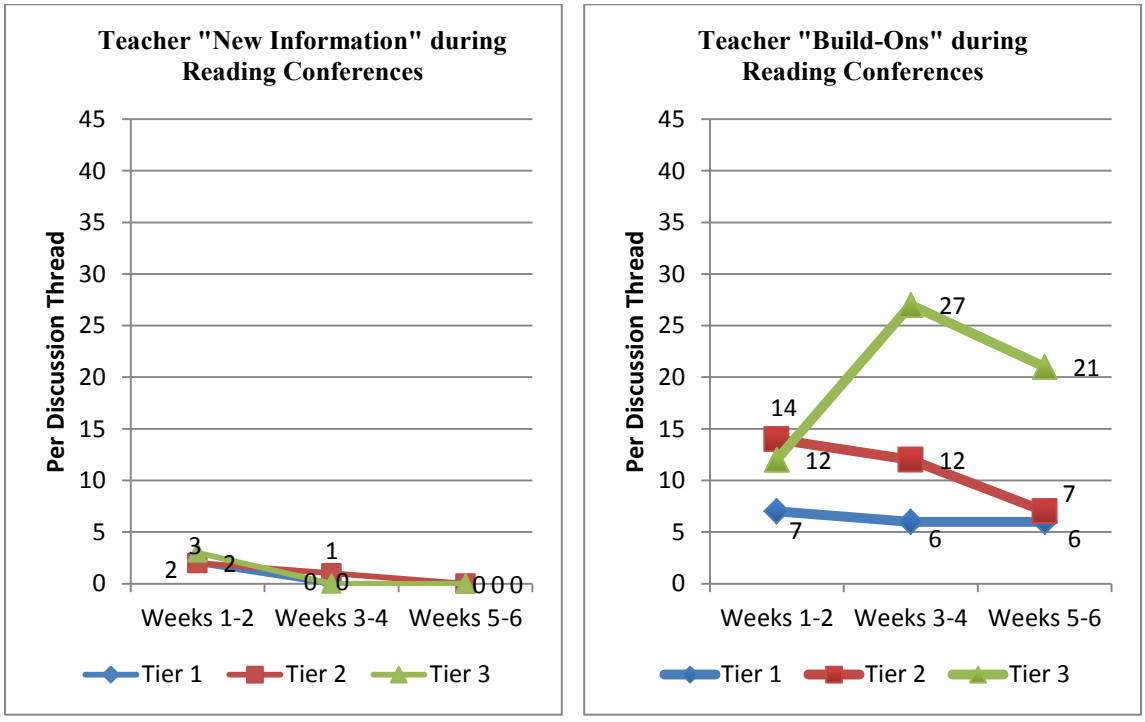


Figure 39. Teacher knowledge building discourse during reading conferences

Teacher building on to information. It is interesting to note that even my own discourse improved with the use of the discussion boards beginning in the third week. Before that, I often said that information was interesting. After, while modeling use of the discussion boards, I more often introduced related information or a related new idea. My proportion of Tier 3 to Tier 2 responses was higher than that of the students, which also provided important modeling for them in engaging in knowledge building discourse. Since questions were also rated as Tier 2, students may have asked more questions of each other in order to learn about different topics. The goal was for children to use higher level discourse, thinking about their own ideas, and both Tier 2 and 3 accomplished this. Based on Figure 39, it is apparent that the teacher engaged in less knowledge building discourse than the students. However, as can be seen in the excerpt below, the teacher also modeled how to discuss ideas about information. In this excerpt, W. introduced new information with an explanation to begin a discussion.

W.: (looking at post-it) If it was not for the sun, all of the planets in the solar system would travel in a straight line and drift into space. And I think this happens because if it weren't for the sun, there would not be anything pulling us together in the solar system.

Teacher: And N. what do you think about that? If you want, you can use your yellow board to answer him.

N.: [flips to yellow board in his journal] What if like if the sun's gravity is too strong, wouldn't everyone go there and get burned up?

W.: Because if the sun gives off too much gravity, wouldn't it pull all the planets in and we'd all die.

Teacher: Here. You made me think, N., that's why maybe some big stars, the planets are further away because it sucked away all the close planets. You guys if you look at your yellow board, can you respond at all? We want to try to make new ideas from all the new info.

W.: Well, I have an idea. If the sun isn't the biggest kind of star that you can have, if the sun was bigger it would even have more gravity and it would pull us in closer and we wouldn't be alive.

The exchange above demonstrates how all of the features discussed in this section, including dialogic and materials instruction, were used throughout the reading conferences. With all of this focus on discussing information and ideas, one might be concerned that students did not advance in their reading comprehension. However, the next section will show that students grew as readers while engaging knowledge building.

Quantity of Knowledge Forum Discourse between Iterations

The remainder of the knowledge building discourse analyzed will be notes from Knowledge Forum software. First, the Knowledge Forum of the second iteration (2012 – 2013) was compared with that of the first iteration (2011 – 2012). Applets within Knowledge Forum ran this comparative analysis (Aguera, 2008; Johnson, 2008; Lea, 2008). Both iterations took place during a 6 week period and included 23 participants. However, the second iteration was composed of more extensive knowledge building discourse. Table 15 demonstrates quantitative differences between the first and second iterations. Knowledge building discourse was more extensive in the second iteration. This can be seen by a number of measurements within Knowledge Forum. First, participants on average wrote a higher average number of notes with greater word diversity. The students of the first iteration wrote a total of 342 notes, and they read (and re-read) a total of 375 notes; the students of the second iteration wrote a total of 661 notes, and they read (and re-read) a total of 671 notes.

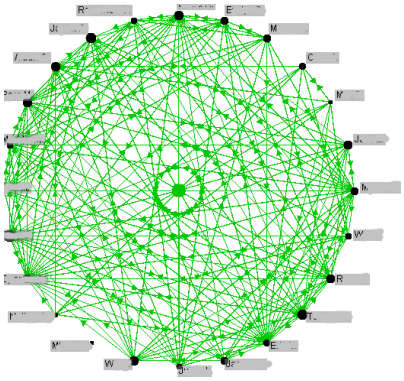
Table 15. Comparison of Knowledge Forum notes in both studies

	Notes per student (average)	Word diversity per student (average)	Total notes written by group (n=23)	Notes read within group	Build-on notes written by group	Average scaffolds used per student	Number of linked notes
First iteration	15	174	342	375	231	2.2	307
Second iteration	28	358	661	671	399	5.2	533

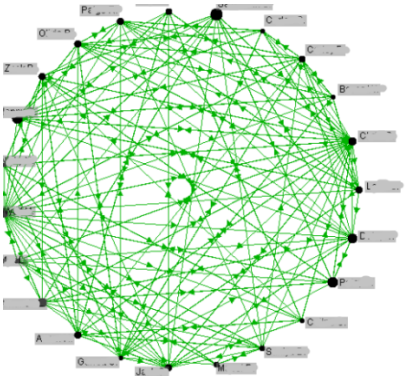
Students also were provided with more Knowledge Forum scaffolds during second study, and they used them more frequently. In the first iteration, a total of 7 supports were offered (Table 3). Students used either a maximum of 4 scaffolds (n=5), 3 scaffolds (n=6), 2 scaffolds (n=4), 1 scaffold (n=3), or no scaffolds at all (n=6). On the contrary, for the second iteration, 10 scaffolds were offered (Table 8). Of those, 3 students used all 10 scaffolds, 3 used 8, 4 used 7, and all students used at least one scaffold. More scaffolds were offered during the second year, because they were tied in with the students' post-its. The total number of build-on notes was greater in the second iteration as well. In the first iteration, 307 notes were linked; in the second, 533 notes were linked to each other.

In addition to a greater quantity of discourse, the second knowledge building group also developed more connections between group members (both in notes read and notes built onto by others). The links between members of the knowledge building community were greater during the second year, as can be seen in Figure 40 created with the SocialNetwork applet (Johnson, 2008). Nodes represent individual students. The lines

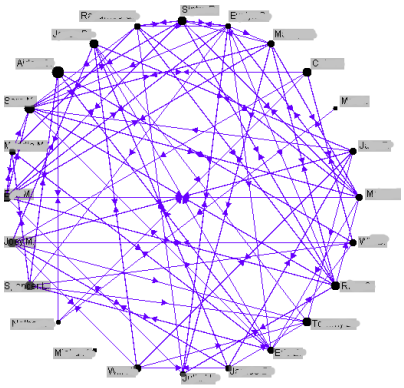
between nodes represent students who read or built onto an individual. For example, the green diagrams below show which students read each other's notes. The blue diagrams show which students built onto each other's notes. The connections between students were denser in the second iteration.



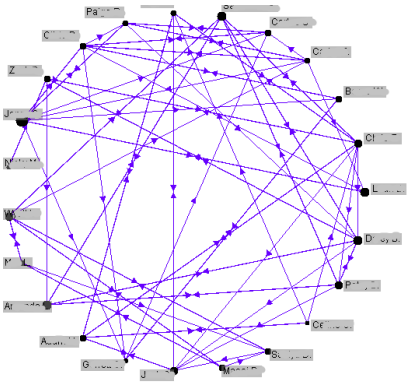
Study 2 notes read connections



Study 1 notes read connections



Study 2 build-on connections



Study 1 build on connections.

Figure 40. Comparison of discourse connections in Knowledge Forum

Quality of Knowledge Forum Discourse between Iterations

In addition to a larger quantity of discourse, the quality of knowledge building discourse in the second iteration had also improved. The graphs below are the same as those presented in Chapter 3; however, the results of both the first and second iterations are now included for comparison. In the first iteration, 79% of children's "new information" notes were Tier 1, without generating ideas or explanations. In the second iteration, only 41% of new information notes were Tier 1. In contrast, 33% of notes were Tier 3, which included explanations or ideas built upon information. A comparison of new information notes between the first and second iterations can be seen in Figure 41.

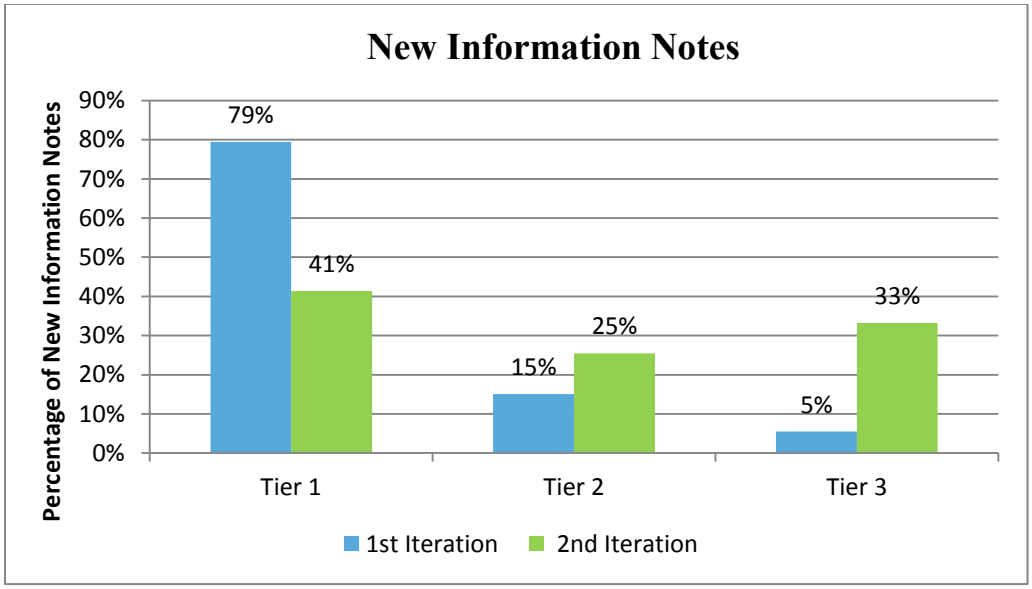


Figure 41. Comparison of "new information" notes between studies

Whereas in the first iteration most "new information" notes were Tier 1, students posted a higher proportion of Tier 2 and Tier 3 notes in the second iteration. For example, in the first iteration, only one note consisted of new information with an explanation.

That explanation, however, did not include much scientifically valid information. The "new information with explanation" note from the first study is shown in Figure 42.

planet x will not hit earth because we cant see it with a teloscop. so there is a good chance planet x doesent agzist.

Figure 42. Tier 3 note from study 1

In contrast, the Knowledge Forum database in the second iteration contained 20 "new information with explanation" notes. As can be seen in the notes below from the second iteration, children often made a point to discuss what they thought about information from an authoritative source. The students in these notes posted scientifically valid information, as well as their ideas and explanations. During the first iteration, students wrote a total of 3 "new information with idea" notes. In contrast, students of the second iteration posted a total of 49 "new information with idea" notes.

Mars

(Support: My Theory) In J.'s book, I read that over million's of years, water and oxygen caused chemical reactions on Mars. Many scientists think that there once was water on Mars. This is my evidence to support that theory. Also, if there was once water on mars, there must have been life on mars. I think this because all life is formed from water, and we need water to live. In the water that once must have been on mars, there must have been tiny organisms swimming around that at a higher point in evolution, would be humans, or something to weird to even think about. Also, relating to that last theory, the last unfiltered glass of water you drank had little organisms swimming in it. This all came from my thoughts, except for the first sentence coming from the book.

Mercury

We can't see mercury because the sun is in the way, it's like a baseball, or a lacrosse ball getting lost in the sun, and the sun is to bright to see it. It didn't say this straight from the book, but I thought of it that way because I took the things around it and put them together to figure it out

Figure 43. Tier 3 notes from planet view in study 2

Students also posted higher quality build-on notes in the second iteration. In the first iteration, most Tier 2 and Tier 3 posts consisted of either questions or related information, leading to a question-answer type discourse. In contrast, the higher level notes of the second iteration consisted of more agreements and disagreements with reasons, as well as more ideas based on others' notes. The comparison between build-on notes can be seen in Figure 44. Knowledge building discourse in the second iteration consisted of more notes, more build-ons, greater word diversity, and more connections between notes. This can be compared to the first iteration in the following graphs.

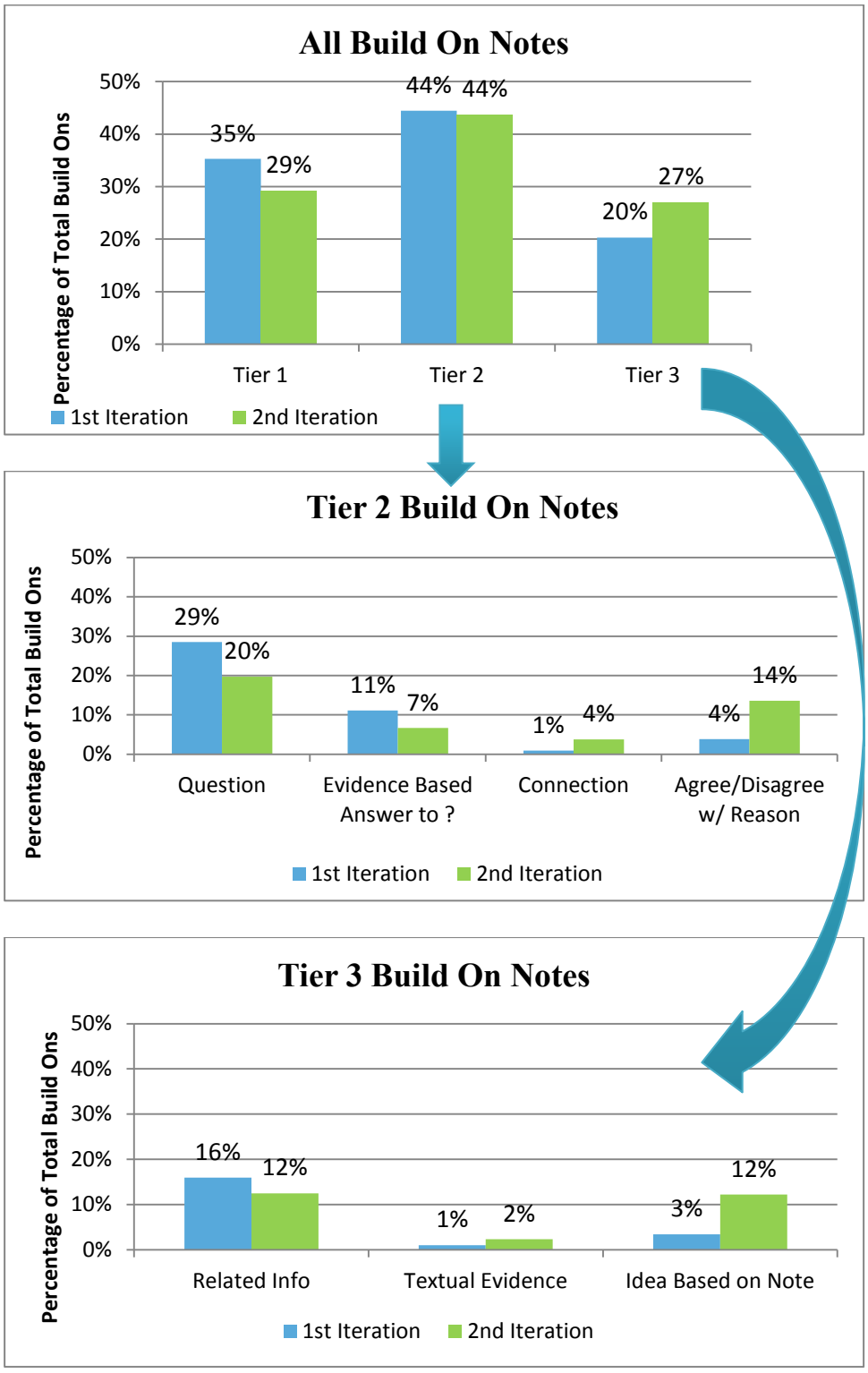


Figure 44. Build on notes comparison between studies

Knowledge Forum Discourse within Study 2

Although the second iteration was more successful overall, some research teams *within* the second group demonstrated more effective knowledge building than others. As described in Chapter 4, students were divided into five research teams. Students primarily posted on their own team's Knowledge Forum view. However, the groups were flexible, and any student could research information or post notes to any view. Table 16 shows the quantity of notes for each view in Knowledge Forum.

Table 16. Total number of Knowledge Forum notes for each research view

View	Total Notes	New Info Notes	Build On Notes
Food Chains	158	52	95
Planets	195	62	96
Chemistry	61	28	29
Animals	98	39	59
History	114	27	66

Quantity of discourse. During coding, notes that began a thread were coded as "New Information". In the Knowledge Forum database during Iteration 2, there were a total of 208 new information notes. There were 345 build-on notes, showing that students more frequently engaged in a threaded discussion instead of beginning their own thread with new information. Some groups had a higher number of new information notes, and thus shorter discussion threads (for example, the planets group). Two groups, food chains

and planets, posted the greatest number of notes. The chemistry group had the lowest total number of notes. The history group had a high quantity of notes, with a higher proportion of Tier 1 notes. In Table 16, the "New Info" and "Build On" columns do not add up to "Total Notes", since a small percentage of notes were coded as conversation or questions.

Within each view, the density of connections between members also varied. This was measured using a Knowledge Forum applet (Johnson, 2008). The food chains group had the densest connections, with a large portion of the class opening that view to read notes and contribute ideas. Compared to the history group, the build-on connections were much denser. The number of connections was also related to the quality of discourse.

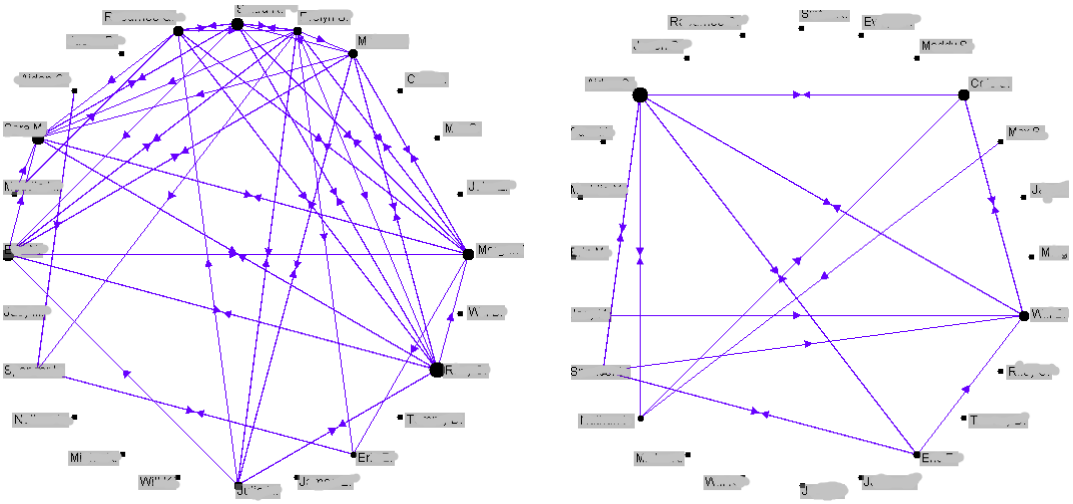


Figure 45. Food chains (left) vs. history (right) build-on connections

Quality of new information. The quality of the notes posted within each view was also examined. As described earlier, "new information" notes were coded into different tiers. Since each group had a different number of notes, the Table 17 shows the

percentage of total new information notes for each group. It is apparent that the Food Chains group had a high proportion of Tier 2 *and* Tier 3 "new information" notes; the planets group had a lot of Tier 3 notes. Both of these groups had the most productive knowledge building discourse in both quality and quantity. In addition, the food chains group had the lowest percentage of Tier 1 notes. In contrast, the history group posted mostly Tier 1 notes.

Table 17. Types of new information Knowledge Forum notes.

Type of Note	**Knowledge Forum View**					
	Chemistry View	***Planets View***	***Food Chains View***	***History View***	***Animals View***	***All Views Combined***
Tier 1 (New info only, or with opinion)	42.9%	40.3%	26.9%	63.0%	46.2%	41.4%
Tier 2 (New info + connection or question)	21.4%	17.7%	34.6%	22.2%	30.8%	25.5%
Tier 3 (New info + new idea or explanation)	35.7%	41.9%	38.5%	14.8%	23.1%	33.2%

Quality of build-ons. Build-on notes were responses to the new information in the chart above. The food chains group posted the highest quality of build-ons, and was the only group with a majority of Tier 3 build-ons. The history group had a lot of Tier 2 build-ons, and many of these were questions. The chemistry group had a high proportion

of Tier 1 notes. The differences in "build-on" notes between the Knowledge Forum views are shown in Table 18 below.

Table 18. Types of build-on Knowledge Forum notes.

Type of Note	**Knowledge Forum View**					
	Chemistry View	***Planets View***	***Food Chains View***	***History View***	***Animals View***	***All Views Combined***
Tier 1 (Opinion)	41.4%	30.2%	23.2%	31.8%	28.8%	29%
Tier 2 (Question, Connection)	41.4%	38.5%	35.8%	59.1%	49.2%	44%
Tier 3 (Related Information, Idea)	17.2%	31.3%	41.1%	9.1%	22.0%	27%

The excerpt in Figure 46 illustrates how the history group had a low proportion of Tier 3 build-on notes. Only one student (the thread starter) was researching Aztecs. When he offered new information, the other students asked questions without contributing new, related information. Although the student who began the thread offered new information with a connection to his own life, his team members did not have the knowledge to continue the discussion. In contrast, members posting to the food chains thread built new ideas with related information.

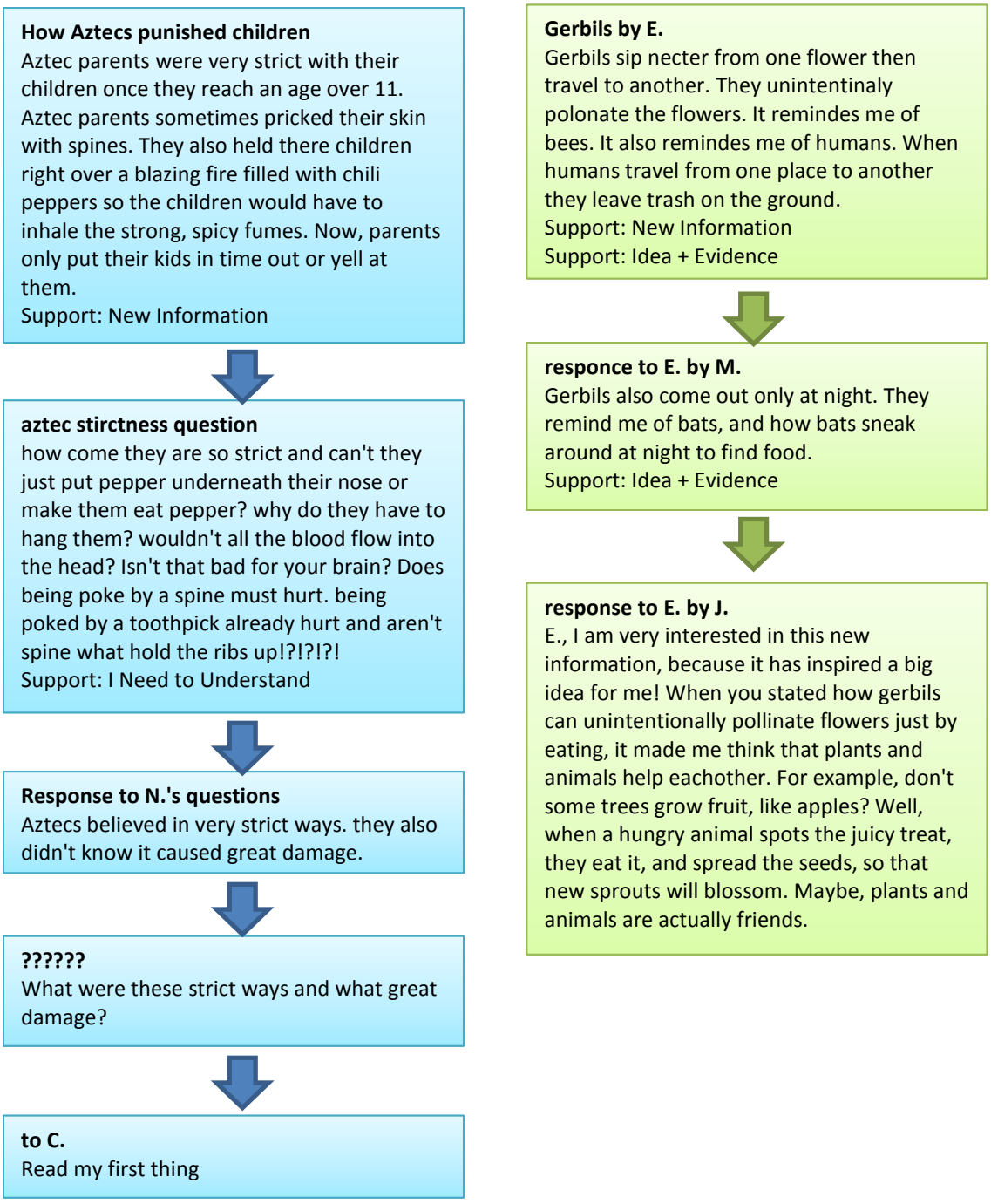


Figure 46. History discussion thread (blue) vs. food chains thread (green)

The quality of explanatory series texts (textual support) is compared with collective responsibility in Table 19. The same trend in quality of discourse is apparent in Figure 47. This suggests that the high quality, explanatory nonfiction text is important to knowledge building. An analysis of knowledge building discourse, along with observations of students' use of text sources, suggests to teachers how to set up and maintain knowledge building during reading instruction.

Table 19. Collective responsibility and textual support within research teams

		Collective Responsibility	
		Low	***High***
Textual Support	***High***	Chemistry	Planets Food Chains
	Low	History	Animals

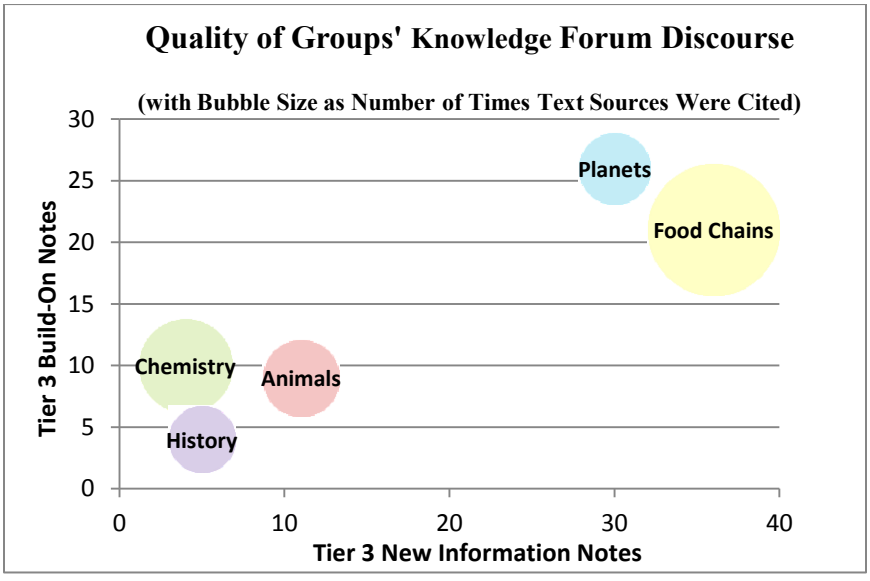


Figure 47. Comparison of research teams' tier 3 new information and build-on notes

Changes in discourse over time. To see how factors such as text support, teacher scaffolding, and student motivation contributed to effective discourse, Knowledge Forum discourse was also analyzed over time. In the previous section, it was shown that the food chains research group posted a higher quantity and of quality notes than the history group. As can be seen in Figure 48, the food chains group generated a higher number of Tier 3 new information notes as time progressed. In contrast, the history group generated a high number of Tier 1 notes during the last two weeks of the unit.

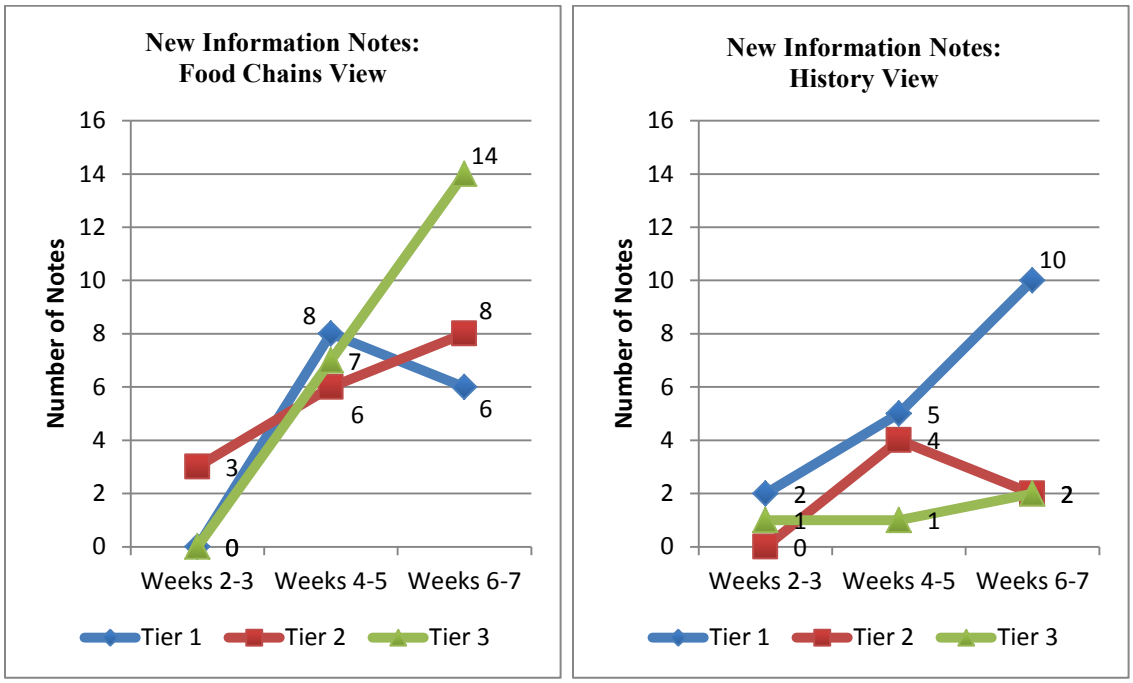


Figure 48. Changes in new information notes over time, food chains vs. history view

The quality of build-on notes posted to the food chains and history views also differed. Figure 49 shows how the discussion declined for the history group during the last two weeks. In contrast, the food chains group improved their discourse each week.

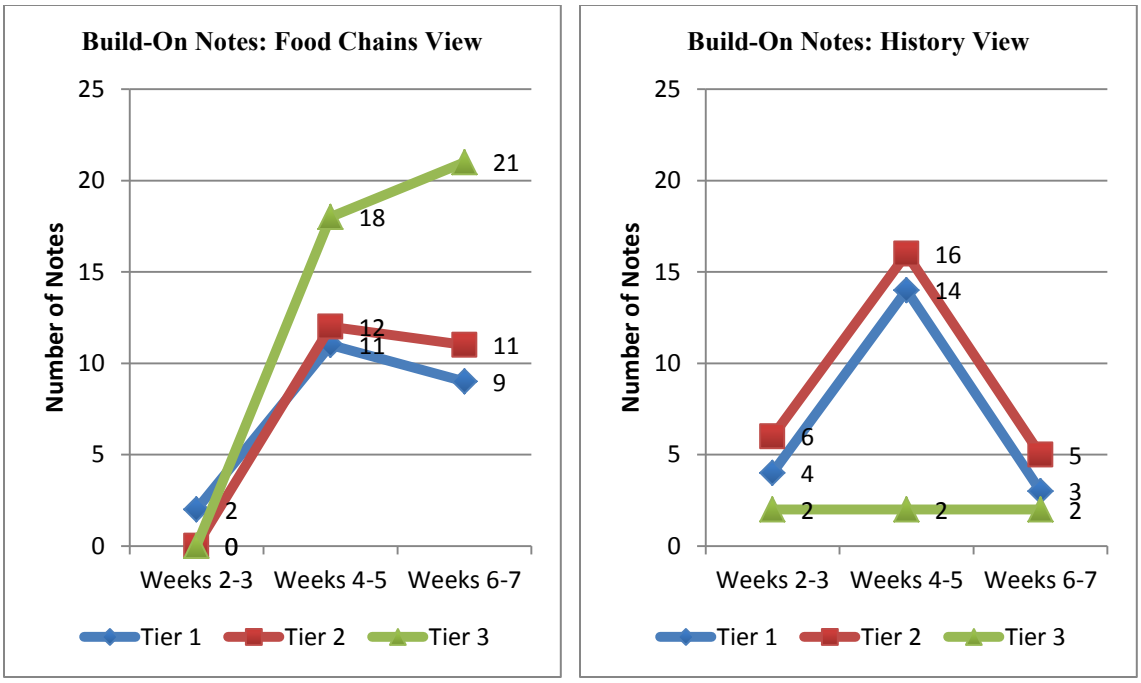


Figure 49. Changes in build-on notes over time, food chains vs history view

For example, the two notes below represent the beginning and end of a five-note food chains thread. Each of the five notes was coded Tier 3, as each student offered related new information:

plants and animals

my big idea is that plants and animals hepl each other. My evidence is that plants are always the start of a food chain. Another piece is that trees provide food and shelter to birds and other animals. My last piece of evidence is that PLants cause fires in the grasslands, and fires help clean habitats. My idea is that plants are like the parents, giving food and shelter, and animals are like kids, trying to stay protected from preditiors.

Big ideas, the friendship of plants and animals

(I agree because) E., there is lots of evidence supporting the fact that animals and plants help each other. For example, grass and grazing animals give each other energy in the food chain. Or like you said, gerbils pollinate desert lilies, and in return the lilies provide gerbils with nourishing food. Trees shelter and feed a huge variety of birds, monkeys, etc. Maybe in a way, plants and animals are friends.

Figure 50. Tier 3 beginning and ending notes from food chains view thread

In contrast, a Tier 3 note was posted by a member of the history group during the same week. Although the post below generated an idea based on new information, no one else in the group built on to the post.

Religion was very important to early humans. Almost everyone's life revolved around religion. Most early civilizations like the Aztec, Inca, Maya, Ancient Egypt. I read a book about each of these people and learned that they had gods of natural aspects such as the sun, moon, water, and harvest. Is that every ancient culture didn't know how exactly things were made, like the sun, moon, and earth. So they believed that there was a god behind everything, so they praised their gods. Early people also belived in magic. They thought all illnesses were realted also to the gods, so magicians also worked with making people better. Normally, magicians would team up with doctors to make someone better. Magicians had an equal statuce to doctors. It would be good if you can consult to the gods!
Support: New Information
Support: My Idea

Figure 51. Unanswered tier 3 new information note from history view

The scaffolds that were used to support this knowledge building were examined in previous sections. In addition, the more successful knowledge building groups also generated the ideas with the highest scientificness.

Scientificness of Knowledge Forum notes. Three groups' Knowledge Forum notes were reviewed using the Next Generation Science Standards. Although the history group researched historical eras outlined in the standards, they did not meet Common Core standards by inferring underlying reasons for historical events. The food chains/animals, planets, and chemistry groups discovered scientific concepts contained in high level content standards. Even as fifth graders, these groups achieved middle school level standards. The planet and chemistry groups also accessed portions of high school level science standards (Appendix C). These standards are based on the Disciplinary Core

Ideas for Middle School Science, according to the Next Generation Science Standards (NGSS Lead States, 2013). The ideas generated by students researching food chains, shown in Table 20, met middle school level Next Generation Science Standards.

The selected notes outlined in Table 20 grew from scaffolds provided to children during reading instruction. In this section, students' Knowledge Forum discourse was examined. This grew out of the scaffolds that supported children in their knowledge building discourse.

Table 20. Scientificness of sample Knowledge Forum notes in food chains view

Middle School Level Next Generation Science Standard	**Knowledge Forum Discourse: Food Chains View**
LS4.D: Biodiversity and Humans *Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to MS-LS2-5)*	On page 15 it said that there are tens of thousands of species of plants and many of them contain medicine that we will eventually need and or find so there will be a solition to may sicknesses. If people keep on cutting down trees than we will nver be able to find the medicine. The habitat loss is increasing every single day and these plants are at risk.Some of the plants there could cure malaria or even help fight cancer.
LS4.B: Natural Selection *Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)*	On page 17 of Survival and Change, it says that small variations such in conditions, such as drier soil or less sunshine, will effect how flowers grow. The picture shows blossoms of the same species that look entirely different. I think this is interesting, that the littlest switchs can change the plant's color, size, etc. I think this is similar with people. Human appearence depends on gender, health, and place of birth. This is what gives earth its variety.

Table 20. Scientificness of sample Knowledge Forum notes (cont.)

Middle School Level Next Generation Science Standard	**Knowledge Forum Discourse: Food Chains View**
LS2.A: Interdependent Relationships in Ecosystems Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)	• Animals food depends on it's habitat. Panda's live in China where theres alot of bamboo. Bamboo is what Pandas eat. Koalas eat eucalyptus leaves. The leaves have poison in them. Koalas only eat that so they have to eat the old leaves because most of the poison has drained out of them. Koalas live in Australia.The reason Koalas and Pandas are endangerd is because their food is running out. I think thats why most animals are endangered. • polar bears arnt loosing their food, they are loosing their habitat. Global warming is causeing the ice to mely, and that is the polar bears most special place to live.
LS2.B: Cycle of Matter and Energy Transfer in Ecosystems *Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. . . (MS-LS2-3)*	• "I Need to Understand" how all living things get energy. All animals would get energy from food. Energy in the food chains begin with sun. Plants get energy from the sun to make food from photosynthesis. Animals hunt to get energy and nutrients from its prey. When a plant or animal dies it still contains energy and nutrients. • Decomposers brake down dead plant and animal matter. EXamples of deccomposers are Fungi, and Bacteria. I have seen FUngus before. The type of Fungus I saw was Mushrooms. Have you seen any types of Decomposers? Also, do you know of any types of Decomposers?
LS2.C: Ecosystem Dynamics, Functioning, and Resilience *Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)*	I think that one of the biggest ideas in food chains is, all animals depend on one another. For example if all the fig plants were gone the quetzals, macaws, tapir, and spider monkeys might starve. Then, the jaguars might also starve and the whole rainforest food chain might dissapear. Once the rain forest food chain disappeared we would no longer be able to get medicine fron trees.

Development of Reading Comprehension

The following assessments did not measure knowledge building. On the contrary, they showed that students were able to improve reading comprehension and skills concurrently with knowledge building activity. This is significant, as it shows that knowledge building can occur simultaneously with literacy development.

Reading Level Growth

The Teachers College reading level assessment was administered to students by their classroom teachers during the school year (Teachers College Reading and Writing Project, 2010). The goal was for students to improve by one grade level, or four reading levels, throughout an academic year. The reading levels are letters of the alphabet based on text complexity, and the May target levels for fifth grade were between S and V. The assessments, which took about a week to administer, were given to my class beginning on December 11, 2012, before the start of the nonfiction unit. They were then administered again beginning February 2, 2013, at the conclusion of the unit. The other fifth grade classes in the school had a similar schedule, allowing a comparison of reading level growth with the treatment class. All fifth grades classes were engaged in a nonfiction Reading Workshop unit; only the treatment class was also engaged in knowledge building with Knowledge Forum.

Rather than demonstrating a significant difference in reading levels, the goal was to show that students in the treatment group did not lag behind other classes in reading level growth due to time taken for knowledge building activities. The data show that during the unit, the average reading level of students in the treatment class went up 1.43 levels. This is important, because it demonstrates that students were able to improve their

reading level during knowledge building. Table 21 shows mean reading level growth during the nonfiction unit. Data was used only for students who were enrolled at the school during both reading assessments.

Table 21. Class mean reading level growth during nonfiction unit

Fifth Grade Class	N	Mean Reading Level Growth	Standard Deviation
1 (treatment class)	23	1.43	0.73
2	25	2.00	0.82
3	24	1.38	0.49
4	24	1.08	0.58
5	23	0.87	0.69
6	25	0.96	0.84

Furthermore, a Tukey Multiple Comparison Test showed no significant difference between the reading level growth of the treatment class compared to the other classes. Table 22 outlines significant differences in reading level growth between the treatment group and the other classes. It can be seen that none of the classes were significantly different from the knowledge building class (Class 1). In addition, standardized test data shows that the knowledge building class achieved literacy standards.

Table 22. Tukey multiple comparison test of reading level growth

Class	Class	Mean Difference	Std. Error	Sig.
1 (treatment class)	2	-.56522	.20383	.068
	3	.05978	.20585	1.000
	4	.35145	.20585	.529
	5	.56522	.20803	.078
	6	.47478	.20383	.190

Standards Based Reading Achievement

One opposition to using knowledge building in the classroom is that it allows children too much time to focus on their own research, instead of on the Common Core State Standards. Therefore, teachers might be reluctant to implement knowledge building for fear that standardized test scores could decline. On the contrary, students in the knowledge building class performed similarly to others on literacy based tests. Students' NJASK scores were compared between fourth and fifth grade. The NJASK consisted of a Language Arts Literacy portion in which students had to read and write both fiction and nonfiction passages. Approximately half of the fifth grade test was nonfiction reading and writing. However, during the school year, the fifth grade students engaged in only two nonfiction reading units. For the treatment group, one such unit of study was the knowledge building study. If knowledge building affected students' development of reading comprehension skills, then one would anticipate their NJASK scores to decline from fourth to fifth grade. On the contrary, the knowledge building class showed a

significant improvement in fifth grade test scores. The NJASK Language Arts Literacy scores range from Partially Proficient (0-199), to Proficient (200-249), to Advanced Proficient (250-300). The mean of the 4th grade scores for the students in the knowledge building class was 222. The following year, in fifth grade, the mean was 232. This data is outlined in Table 23.

Table 23. ASK score means for knowledge building class

		Mean	N	Std. Deviation
NJ ASK Language Arts Literacy scores	4th Grade (2012)	222.45	22	18.74
	5th Grade (2013)	232.00	22	25.86

Based on the students' scores, a paired samples t-test shows a significant improvement in the fifth grade NJASK scores, $t(21) = -2.39$, $p = 0.026$. Knowledge building did not hinder student learning towards curriculum goals. However, the increase from 4th to 5th grade could also be due to the school-wide adoption of the Reading Workshop curriculum. Therefore, it is useful to compare the knowledge building class with the rest of the fifth grade, to see whether they were able to achieve comparable scores in the 2013 test of Language Arts Literacy. The overall mean of the treatment group ($M = 232.0$) was consistent with that of the entire fifth grade ($M = 227.3$). Based on the data, knowledge building during reading appears to support students' achievement of literacy standards.

Nonfiction Reading Comprehension Pre- and Post-Tests

Students performed better on the multiple choice questions of the pre-test (M=80, SD=16) than the post-test (M=71, SD=12). Even though these were leveled reading assessments provided by an online curriculum provider (www.readinga-z.com), the post-test multiple choice questions may have been slightly more difficult. The post-test topic, "Saving the Salmon", described the process of migration. In addition, students read both pre-and post-test using an iPad. However, on the post-test only, they also answered multiple choice questions on an iPad, so may have been more reluctant to look back in the text while answering questions. Alternatively, the knowledge building unit may not have improved children's ability to answer multiple choice questions.

However, an interesting trend is noticeable between pre- and post-tests. Students had to answer two open-ended written responses for the pre- and post-tests. The responses were then rated using the NJ State Rubric for written response to literature. The goal was for students to receive a score of 3 on their response, meaning that they came up with their own ideas based on textual evidence, instead of just quoting from text. A score of 2 means that the students answered the questions correctly, yet simply quoted evidence from the text without stating their own ideas. Since there were two open ended responses, student scores were added together, for a minimum score of 2 and a maximum of 6. On the pre-test, students averaged about 2, or 4 total, for each question ($M = 4.42$, $SD = 0.75$). The post-test scores were higher ($M = 5.48$, $SD = 0.68$). A paired samples t-test shows a significant difference in students' ability to write a response including their own ideas based on textual evidence, $t(20) = 5.966$, $p = 0.000$. After engaging in knowledge building, students were better able to generate ideas based on textual evidence.

CHAPTER 6: DISCUSSION

Children will one day become members of knowledge building organizations, to work with an ever-growing array of knowledge. In order to prepare them for future knowledge work, classroom pedagogy must align with knowledge building principles. This study demonstrated how reading instruction supported knowledge building in a fifth grade classroom. Students were motivated to learn, assumed collective responsibility for building knowledge, and made constructive use of authoritative text sources.

This research was built upon other Knowledge Forum studies that scaffolded children's ability to rise above text sources (Sun et al., 2010; Zhang et al., 2007). In addition to analyzing Knowledge Forum discourse, this study also examined face-to-face knowledge building discussions in the classroom. During reading conferences, children participated in a cognitive apprenticeship that scaffolded knowledge building within a community of learners (Collins, 2006). They received feedback from the teacher in applying dialogic skills. Similarly, previous studies also focused on dialogic instruction with scientific texts (Guthrie et al., 2004; Romance & Vitale, 2001). In this study, children practiced knowledge building during face-to-face discussions with their reading partner and research group. In addition, they posted knowledge and ideas within the Knowledge Forum computer environment. In the remainder of this chapter, these findings will be discussed based on each research question.

Instructional Design (Research Question 1)

There were many different instructional methods that were developed during this design study. The methods were developed at the lesson and unit levels. The design

resulted in a method for teaching nonfiction, as well as pedagogy for supporting knowledge building principles. These instructional strategies were based on both dialogic and knowledge building principles. The findings have implications for both educators and researchers.

The instructional strategies mirrored balanced literacy instruction, often referred to as a reading workshop approach (Calkins, 2001; Fountas & Pinnell, 2006). The teacher planned minilessons, met with students in one-on-one conferences and small groups, and assisted students during independent research. In addition to reading strategies, small groups were also based on dialogic instruction. In this method, the teacher modeled and scaffolded knowledge building discourse during reading conferences. This gave children a chance to practice knowledge building discourse in many settings, both with and without teacher guidance. These instructional strategies can be practically applied by elementary educators who are familiar with best practices in literacy instruction.

Classroom Environment

In the knowledge building literature, many classrooms were within laboratory schools (Hewitt, 2004; Oshima et al., 2006; Zhang et al., 2009). The design based approach applied in this study set out to create principled, practical knowledge. This design study, therefore, created instructional methods for fostering knowledge building in the reading classroom. These will be outlined in the following sections.

Setting up research teams. Research teams developed their own classroom norms when working together. For example, many students picked shared spaces and read together silently in a circle. They often requested to meet in certain spots when discussing texts with a partner or group, for example at the front table in the classroom.

In order to pick teams, the teacher gave a book talk on the first or second day of the nonfiction unit. During the book talk, she introduced the series and showed students the topic and the inside of the books. Children then wrote their first, second, and third choice for a research team on a slip of paper. The teacher was thus able to make research teams that would work well together. Children were matched to series books at their independent reading levels, and various levels were included for different research topics.

Supplies and materials. During the unit, children used journals and post-its. They also kept a reading log each day. In addition, copied discussions boards were glued into student journals. Series trade books were also used, and were kept in baskets for each group. Children were able to choose books from any of the group's baskets. When reading independently, children kept their nonfiction research books in their book bins, along with post-its and journals. They referred to an anchor chart when writing post-its, and also organized their post-its in their journals into categories. The combination of supplies allowed children to develop ideas and theories based on book research. First, they had shared texts that they could discuss with a group. Since children were reading the same concepts over and over, as well as discussing them online in Knowledge Forum, they began to make connections between their own ideas and the books. Also, writing post-its about books allowed them to record their own new ideas and information before posting to Knowledge Forum. First, this ensured that they did not plagiarize directly from the book. Also, it gave them an individual space to stop and think about the book before sharing it with a group. Similarly, journals allowed students to organize information into concepts, and to rise above their individual post-its and to put them into categories. This assisted children in developing big ideas based on their research.

Lesson Structures

This dissertation research showed the importance of discussing content when reading informational text, which was also demonstrated in other studies on dialogic instruction (Mercer et al., 2009). When provided with a routinized, predictable structure, the students could take the initiative for learning and were able to direct themselves in knowledge building activities. First, the teacher modeled a skill or strategy during a minilesson. This skill or strategy could be dialogic (such as meeting and talking with a partner with a discussion board) or based on reading strategies (such as identifying main ideas and details). Next, the teacher met with a small group while other students researched independently or posted on Knowledge Forum. Finally, students met with research partners to discuss the new information and ideas they found during independent research.

Unit plans. The unit structure also followed a predictable pattern, from lower to higher complexity (Collins, 2006). During the first week, children chose their research teams and were introduced to the nonfiction genre. In the second week, they focused on writing gold and silver post-its. This ensured that they were thinking about new information while reading. During the third and fourth weeks, instruction shifted to organizing and categorizing post-its, which moved students from thinking about information to thinking about concepts and ideas. Children also began posting on Knowledge Forum during this time. Reading conferences followed the sequence of events of the unit.

The current study is unique in that it combines both reading strategy and dialogic instruction with knowledge building activities. The questions posed by the teacher during

reading conferences about information, thinking, and big ideas were similar to reciprocal teaching, prompting students to think about and work with texts (Caswell & Lamon, 1998; Palinscar & Brown, 1984). This study provided the opportunity for children to work within their zone of proximal development while building knowledge from text sources (Vygotsky, 1997). Scaffolds were gradually removed as children became more adept at engaging in knowledge building discourse.

Instructional Scaffolds (Research Question 2)

The scaffolds developed through design research were based on reading instructional methods (Calkins, 2011; Fountas & Pinnell, 2006; Tracey & Morrow, 2012), cognitive apprenticeships (Collins, 2006), and knowledge building (Scardamalia & Bereiter, 2006). This study found that dialogic and content knowledge scaffolds helped students build knowledge during reading conferences. First, an analysis of the reading conference data showed how using a discussion board facilitated discourse between students. Also, providing content knowledge and asking questions about texts during conferences helped students to build knowledge. A qualitative analysis showed that topics brought up in reading conferences were often discussed later within Knowledge Forum.

Reading Conferences

Reading conferences scaffolded dialogic practices during small group instruction. During conferences, children first began by working with pieces of information by writing post-its from books. Next, they generated ideas by organizing the post-its into concepts. Later, children discussed big ideas when they thought about theories based on textual evidence. During conferences, the teacher made decisions about which type of

instruction was most needed for students. Included in conferences was work with reading strategies, informational text features, dialogic instruction, and knowledge building discourse.

Scaffolding trajectory. Students worked on dialogic skills and knowledge building during weekly reading conferences. First, at the beginning of the knowledge building unit, children worked with new information. In this phase, children were prompted to rise above text sources (Zhang & Sun, 2011). However, like in other knowledge building studies, they were also prompted to find "new" information that no one in their group knew (Hewitt, 2004). This combination allowed them to write a lot of post-its and think deeply about information. In this phase, children practiced writing ideas, questions, connections, and even opinions along with new information. During conferences, they talked about their new information and worked on rising above text sources.

In the second phase of scaffolding, children worked to organize their information into larger concepts. Reading conferences focused on organizing post-its into categories within reading journals. This follows other research on children's concept formation (diSessa, 2006). In this dissertation study, children used text sources as evidence in creating concepts to back up new ideas. In addition, during this phase, children used discussion boards during reading conferences and group meetings. These discussions boards helped them to engage in face-to-face knowledge building discourse. Once they were thinking about information, organizing it into concepts, and discussing ideas and evidence, children began posting on the Knowledge Forum collaborative environment.

After children had been working with concepts and discussing their idea on Knowledge Forum, they were prompted to generate big ideas, an essential component of knowledge building (Chen, Chuy, Resendes, & Scardamalia, 2010). Children wrote about big ideas in their journals, and also discussed them during reading conferences. If information was organized into concepts, then concepts were organized into big ideas. This helped children to build new understandings around knowledge they learned from text sources. During this time, they continued working with their discussion boards, although they often did not need to refer to them in during discussions. The groups working with explanatory texts had developed shared knowledge and ideas around their topic. The scaffolds, described in the results section, supported children in building knowledge from text sources.

Distributed Scaffolds

Throughout the unit, children used tools to support their knowledge advancement. Some of these tools arose from models of reading instruction. Journals and post-its, used in the Reading Workshop model (Calkins, 2011), helped to strengthen children's independent knowledge building with texts. Other scaffolds, such as discussion boards, were developed to enrich face-to-face discourse. This design study resulted in pedagogical tools to support children's knowledge building discourse around information text sources. Discussing ideas, through collaborative discourse, helps children to advance knowledge and develop theories (Scardamalia & Bereiter, 2006).

Anchor charts also provided distributed scaffolds in the classroom (Puntambekar & Kolodner, 2005). Children often referred to the anchor charts when posting ideas with post-its and on Knowledge Forum. These anchor charts became shared scaffolds that

were used by the class (Puntambekar & Hubscher, 2005). Post-its also served to scaffold students. First, they allowed children to post information in their own words, and to have readymade connections or questions to include in their Knowledge Forum posts. When working from post-its, the online posts were longer and more detailed. In a sense, children used the post-its and journal as an intermediate, individualized knowledge building step, where they transformed knowledge from the book into knowledge of their own. This individual knowledge was then posted, and became knowledge building discourse that was transformed by the group. Also, the discussion board helped students to engage in face-to-face knowledge building discourse, which would later be transferred to the Knowledge Forum database.

Knowledge Building Discourse (Research Question 3)

Knowledge building discourse improved with the second iteration, and even differed between groups. One benefit of design research is that it can take into account multiple unanticipated variables (Middleton et al., 2008). In the second study, every knowledge building group was given the same planned scaffolds. Even with these scaffolds, the groups engaged in different levels of knowledge building discourse when rising above text sources. The results of the current study support previous literature regarding knowledge building principles (Scardamalia, 2002).

Groups that focused on the principle of collective responsibility were also able to constructively use authoritative sources. For example, even though all groups received the same scaffolding, the food chains group was better able to engage in knowledge building discourse around authoritative sources. In this group, students responded to others' ideas, sharing related evidence from text sources. The group also read together in

a circle almost every day, showing a democratization of knowledge (Scardamalia, 2002). All group members took collective responsibility for researching. When members made inferences and discussed ideas, they also provided textual evidence for claims. This heavy reliance on text sources, along with shared responsibility and collective knowledge advancement, enhanced the reading conference scaffolds that had been developed throughout the design study. In contrast, the discourse of the history group was more confrontational than collaborative. They talked about knowledge as though there were one right answer, instead of democratizing knowledge (Scardamalia, 2002).

Figure 52. Research team reading in a shared, chosen space on the carpet.

It appears that the planets and food chains groups had the highest quality discourse. These groups shared a number of features in common. First, they each had at least five members, the majority of whom assumed collective responsibility for knowledge building. In addition, they began their research with explanatory series texts.

These series each consisted of 6 to 8 titles, so students had a number of books to read in order to develop concepts.

The less successful groups were lacking collective responsibility, explanatory texts, or both. For example, the chemistry group consisted of two members who were interested in atoms, and one who was interested in crystals. With so few members, they contributed less new information. Although they had a high quality, explanatory series, it contained only four titles. Their discourse showed a high level of scientificness, but was not as extensive as the food chains and planets discourse. In contrast, the history group did not use series texts or demonstrate collective responsibility. In that group, some members posted high quality notes yet were critical of others' ideas. Other members contributed only a few notes to the database, and still others posted ideas without evidence.

This supports previous research, in that it is important for teachers to foster collective responsibility around knowledge building. Groups can have a shared space where they read, meet together at the end of workshop to discuss big ideas, and use a discussion board to scaffold discourse. During reading conferences, groups can be taught to support theories with textual evidence, and to respond to others' ideas. When students' discourse is supported in a face-to-face cognitive apprenticeship, children later apply it to independent discourse within Knowledge Forum.

Limitations

A few limitations existed in this study. First, the practitioner research model presented pros and cons. The benefit was that it allowed me to change the design based on day-to-day observations. However, the study was limited to one class of students.

Much of the observations were made based on reading conferences where I taught students. Also, the video did not record on two days, so those conferences were not included in data analysis. In addition, a literacy coach met with two to four students on one day each week; these conferences were not recorded or coded. However, she asked students to retell textual evidence and ideas, so it supplemented the reading conferences in the study. The pre- and post-tests, although on the same reading level and subject areas as students' independent reading, consisted of slightly different topics. This may have interacted with students' prior knowledge. In addition, students answered multiple questions on the iPad for the post-test, and with paper-and-pencil for the pre-test. This may have affected their multiple choice scores. However, students took the open-ended portion of both pre- and post-tests on paper.

Significance

This design study has implications for both teaching and research. It looked at a specific aspect of knowledge building: constructive use of authoritative sources (Scardamalia, 2002). This design based study showed that it was possible to foster high levels of scientific content learning while teaching children strategies of reading informational text. Since time is often lacking in the school day, this shows how knowledge building can be integrated with existing curriculum. The methods designed in this study can be scaled up to other classrooms and schools, by supplementing instruction with informational texts during reading instruction. The pedagogy presented in this study also supports national science and reading standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). In sum, this study combines knowledge advancement with reading instruction, showing a method of

applying knowledge building in the elementary classroom.

In knowledge building, children develop improvable ideas based on authoritative sources (Scardamalia, 2002). This dissertation showed how ideas, originally based on nonfiction text sources, developed over time through knowledge building discourse. Such a qualitative analysis was made by tracking the progression of ideas in both face-to-face and online Knowledge Forum discussions. The design study also developed a model for scaffolding students' use of text sources within a cognitive apprenticeship (Collins, 2006), as well as a tiered coding scheme for analyzing children's ability to rise above text sources in knowledge building.

Constructive use of authoritative sources is an essential principle in knowledge building (Scardamalia, 2002). Using design principles, this study developed scaffolds to support children's ability to rise above text sources. In addition, children included advanced scientific concepts in their discourse. These methods can be applied by teachers in fostering knowledge building during nonfiction reading. In addition, this study supported previous research on the importance of idea improvement and collective responsibility in knowledge building. The model developed in this study can help children to build knowledge based on text sources, providing a principled, practical model of knowledge building within literacy instruction.

(I Need to Understand) why in the food chains book it says that hunting, farming and mining are in almost every habitat? There can not be everything you need in every habitat! Think about your world,don't you want to live in a beautiful place?

Figure 53. Student's Knowledge Forum post

Concluding Thoughts

This dissertation began with one student's wonderings about the Universe, and concludes with another's ideas about our world. Children, by engaging in knowledge building, became cognitive apprentices who worked with new knowledge to generate ideas and theories. The post above shows a student who is a legitimate participant, collaborating within a community, and imploring other children to "think about your world". During knowledge building, even within the context of state and national curriculum standards, children recognized that they were engaged in authentic and important work. The results of this design study demonstrate how students created knowledge about their world, their Universe, and their place within them, while building knowledge as a collaborative community.

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APPENDIX A: Knowledge Forum Worksheet

Knowledge Forum Checklist

Name _____ **Date** _____

Please check off each number as you complete them.

___ 1) Log in and go to your group's research page.

___ 2) Read all of the "new blue" notes. Everything should be red/read. As you read, record notes you build on in the chart below. You can build on with "new info" or "new ideas":

Notes I Built Onto (Person / Note Title)	My New Info / Idea

___ 3) Look through your post-its for new information and ideas that *no one* has posted yet. Now, you can write your own notes. Record your notes in the table below:

My Note Title	My New Info / Idea

APPENDIX B: Discussion Board

New Information 	New Information 	New Information 	New Information 
Idea + Evidence I think. . .because 	Idea + Evidence I think. . .because 	Idea + Evidence I think. . .because 	Idea + Evidence I think. . .because 
Discuss Picture & Diagram 	Discuss Picture & Diagram 	Discuss Picture & Diagram 	Discuss Picture & Diagram 
Text to Self Connection 	Text to Text Connection 	Text to World Connection 	Text to Knowledge Connection 
Share related new information. 	Share related new information. 	Share related new idea. 	Share related new idea. 
Ask about new information. 	Ask about new information. 	Ask about new idea. 	Ask a question. 

APPENDIX C: Scientificness of Knowledge Forum Notes

Next Generation Science Standard	Knowledge Forum Discourse: Planets View
ESS1.A: The Universe and Its Stars *Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)* *Middle School Level*	i wonder if there is life on any of the other galaxys. since we cant get out of the milky way, we dont know if theyre is even people on other galaxys. there could be. i think that scientists should make some thing that runs for ever . like a little rocket that has a built in camera, and runs on space stuff. mabe one day we will see other galaxys and me a new kind of person.
ESS1.B: Earth and the Solar System *The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3)* *Middle School Level*	I learned that on Venus there are 225 earth days when there are 365 earth days on earth? I think that it is because Venus is closer to the sun than the earth so Venus can go around faster which will lead to less days. I have a inference because I think that the planets behind the earth have more days than the earth and other planets infront of the earth because they are behind the earth and take longer to go around the sun because it is farther away. I wonder if I am right?
ESS1.A: The Universe and Its Stars *The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (High School-ESS1-1)*	I learned that the sun was born 4.65 billion years ago. From other books I read that the sun will dieout/explode in 5 billion years.Based off that I think that stars only live for 10 billion years. Also that the sun is just about 1/2 way done with its life.
ESS1.A: The Universe and Its Stars *The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation. . . (High School-ESS1-2)*	For the planets group this was one of our big ideas the big bang was the most imortant scene ever of our universe because it was the creation of our universe it may have formed from litterally nothing whan that part of nothing formed a giant fireball with almost infinite density and temperature when that was just floating there when it suddenly exploded and formed our universe
ESS2.A: Earth Materials and Systems *Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. (HS-ESS2-3)* (The excerpted Knowledge Forum note demonstrates only a portion of this standard; however, the high school level was included since the standard does not appear at the middle school level.)	the earth and many other planets have many layers. us as earth, have a thin crust, then a mantle, than even deeper, a big metle ball called the core, is like a burning hot magnet. earths core keeps our magnetic field moving at all times. think of an apple. wate no, a peach. a peach has the skin, as its crust, then deeper is the guwwy juicy stuff as the mantle, and then the deepest part as the pit in the peach and the core of the earth,. . . i have also learned that the … diagrams of other planets layers… are made up of the same things the many other planets, have a thin crust, then a mantle, and then a core smack in the center of the planet that some planets cores even have a magnetic field powered by the core just like us on earth. so earths layers and other planets layers play a huge role in space …

Next Generation Science Standards	Knowledge Forum Discourse: Chemistry View
PS1.A: Structure & Properties of Matter Substances are made from … atoms, which combine with one another in various ways. Atoms form molecules that range in size from 2 to 1000s of atoms. (MS-PS1-1)	The more protons, neutrons, and electrons in an atom, the bigger the atom. If you really think about it, an atom is 1/1000 of a molecule. If you really really think about it, the molecule actually is slightly bigger than molecules with slightly smaller atoms.
PS1.A: Structure & Properties of Matter Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)	… dimond rings are made out of real crystals. We can tell because the telascope that can see atoms can see inside of a dimond AND glass. The atoms in the dimond are tightly packed. The atoms in glass are floating around all over the place. The cool thing is that if you want to buy a dimond and it seems low price, you can tell if it is a real dimond or glass!
PS1.B: Chemical Reactions Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties… (MS-PS1-2)	Do you know how atoms form molecules? Well, it starts like this. Two atoms approach each other. Their electrons sometimes move around. And the atoms turn from a circle to a lump of atomness. Then connect forming what looks like a Venn diagram. The nucleuses are on the sides of the "both" section. And the electrons are on the top and bootom of the "both" section.And then it is a molecules
PS1.A: Structure and Properties of Matter The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6)	… on page 10 of Atoms and Molecules, it talks about atoms being held together. If you read closely, it talks about invisible forces called bonds. They hold the atoms in molecules together so they don't go flying all over the place. The bonds are formed by electrons in the atoms. My theory's that whenever a gas has its particles bouncing around, something has gone wrong with the bonds
LS1.A: Structure and Function All cells contain genetic information in the form of DNA molecules…(secondary to HS-LS3-1)	DNA is basically a bunch of atoms in ones body. DNA is in every living thing. It changes how people look and their hobbys. It creates life. DNA is made up do spirals. If you want an image of DNA, I posted it in the next note
PS1.A: Structure and Properties of Matter Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)	But atoms aren't the smallest peice. There are even smaller peices called particles. Types of particles are protons, neutrons, and electrons. A clump of particles are called a nucleus. The protons and neutrons are clumped together and the electrons whiz around them. Electrons are the smallest type of paricle. Electons stick to protons like magnets.
PS1.A: Structure & Properties of Matter The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1),(HS-PS1-2)	Elemernts make up lots of rocks, gases, and liquids. Oxygen is what we breath. The oxygen element is made up of the oxygen atom. The bismuth element is made up of bismuth atom(just saying, bismuth rocks are rainbow and flat and geometricly spiraly). Scientist know of 118 known elements and more are being discovered every month(not everyday). There are different types of elements, alkali metals, transition metals, ordinary metals, halogens, and rare earth metals. All the elements make up the periodic table which is sorted by number and the atomic weight, and the elements reactivity.

APPENDIX D: Reading Comprehension Pre-Test for Study 1

The Internet

Written by Ned Jensen

www.readinga-z.com

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Introduction

Can you imagine life without the **Internet**? Well, it might be hard to believe, but just a few decades ago, the Internet did not exist. The Internet has changed our lives and continues to change our lives, perhaps more than any other invention since the computer. The Internet has changed the way we communicate, gather information, shop, pay bills, and learn.

What Is the Internet?

Simply said, the Internet is awesome. It is a system or network that connects millions of computers around the world. Any computer connected to the Internet can exchange packets of information with any other computer connected to the Internet. These connections allow information to pass from computer to computer at the speed of light. Information packets sent from one computer can reach another computer on the other side of the world in just a few seconds.

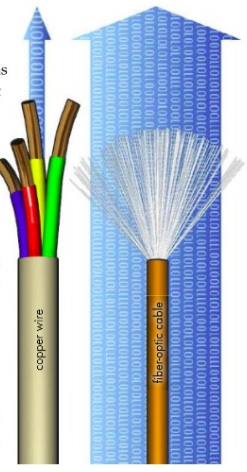
A series of ones and zeros make up the information packets computers send and receive.

How Is Information Sent?

Information packets sent over the Internet includes words, pictures, sound, and video. All of this information flows through wire or **fiber-optic** cable. Wire cable is made from copper or other metals, while fiber-optic cable is made from bundles of very thin strands of glass or plastic. Internet information can also be sent wirelessly on radio waves. This is known as **WiFi**. A receiver within a WiFi network collects the information packets from radio waves. The receiver takes that collected information and sends it through the wire or fiber-optic cable that connects the receiver to the Internet.

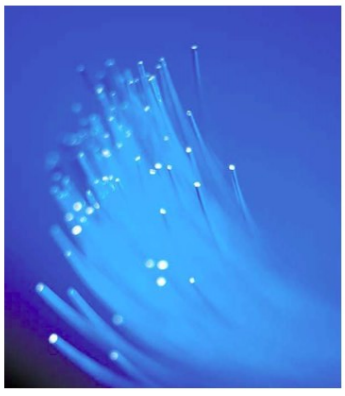
Fiber-optic cables are made to quickly carry huge amounts of information.

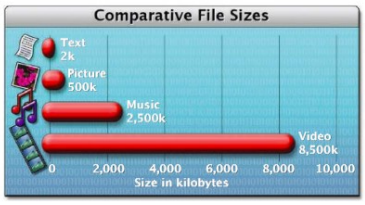
The amount of information moving over the Internet at any given time depends on what is called **bandwidth**. The bandwidth of a cable allows information to move like cars on a highway. The more lanes a highway has, the more cars that can travel on it. Greater bandwidth means that more information can travel through a cable. However, as with heavy traffic on a highway, when the amount of information traveling through a cable increases, the speed at which it travels decreases.



It takes two copper wires to carry one phone call. It takes two strands of fiber-optic cable to carry 24,000 phone calls.

Fiber-optic cable has greater bandwidth than wire cable and, therefore, can carry thousands of times more information than wire cables. As we become more dependent on the Internet for information, bandwidth becomes more important. Sound, pictures, and video all require more bandwidth than text. Therefore, information containing **multimedia** content needs greater bandwidth to flow through the Internet quickly.





Bandwidth is a measure of the number of units of information prepared and sent by computers that can pass through the Internet per second. The smallest unit of information is called a **bit**. When eight bits are combined they become a **byte**.

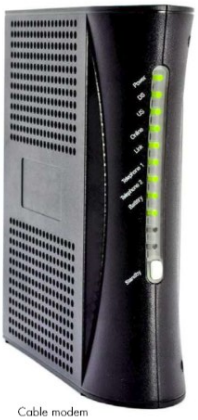
A single letter of text, such as the letter *A*, is one byte. Compare a typical typed sheet of paper, which has 2,000 bytes, with a short novel, which has one million bytes! Megabytes (1,000 kilobytes) and gigabytes (1,000 megabytes) are common measurements of computer storage capacity.

Math Minute

If a kilobyte is 1,024 bytes, how many bytes are in a 1-megabyte photograph?

How Does the Internet Work?

The backbone of the Internet is a permanently connected network of powerful computers to which other computers can connect. Individual computers connect to the Internet through a device called a **modem**, which decodes and codes digital information as it passes to and from your computer. You can access the Internet by using a modem and logging in using a username and password. Internet access is usually purchased from an Internet Service Provider (**ISP**) for a monthly fee. ***Broadband*** users pay higher fees for high-speed Internet access using DSL or cable modems.

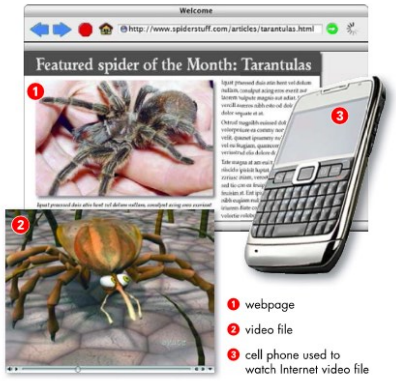


Cable modem

The Internet allows people to share information, including pictures.

Once you have access, you are free to surf the Internet. You can send information to, and receive information from, anyone else that is hooked up to the Internet. Let's say a friend tells you about a website where you can get information about tarantulas. You type in the website **URL** he gave you, including the file name, press "enter" (or "return") on your keyboard or click the go button of your **browser**, and within seconds an article on tarantulas appears on your screen. So, how did this happen, you might ask.

Here is a simple explanation of what happened. First, a browser, special Internet software for finding and looking at webpages, connected your computer to a **server** somewhere on the Internet. Next, the browser requested the website information. Then, the server retrieved the requested information and sent it back to your computer. Once the browser found the page you wanted, it made it possible for you to view the page on your computer.



An information technology expert makes sure servers stay connected to the Internet.

Let's take a closer look. All the computers that make up the Internet can be put into two groups: servers and **clients**. Servers are computers that provide a service, which is to give access to information. There are different kinds of servers. For example, to send or receive email, you will connect to an email server. To request information from a website, you will connect to a website server.

The other computers on the Internet are computers like yours, called clients. Client computers don't provide a service, but they do send and receive information.

Every computer connected to the Internet, whether a server or a client, has an **IP address** (IP stands for Internet Protocol). Each IP address is a unique series of numbers. The numbers are arranged in four sets with each set separated by a dot. For example, 209.104.1.69 is the IP address for the computer that stores information for the website known as Raz-Kids, where students can read books their teacher has assigned. But since most people have a hard time remembering a series of numbers, computers are given **domain names**. The domain name for the Raz-Kids computer is raz-kids.com.

University students take advantage of free Internet access for communication and research.

How Did the Internet Begin?

Most people think it all began back in the 1960s. The United States Department of Defense wanted to establish a dependable network of communication in case of a disaster or war. The network that was created, called ARPAnet (Advanced Research Project Agency network), linked four computers to each other. By the 1980s, hundreds of computers were linked together. Soon, universities began building their own networks of computers so they could more easily share information. One of the largest networks for universities, called NSFnet (National Science Foundation network), came to be called the Internet.

Tim Berners-Lee

In the 1990s, a physicist named Tim Berners-Lee changed the Internet forever. Before Berners-Lee, a network would "talk" to its many computers, but could not share information with other networks. Each network spoke its own language and could not understand other networks, like people from different countries who spoke different languages. Berners-Lee solved this problem by writing a common language that let computers in various networks "talk" to each other.

How Is the Internet Used?

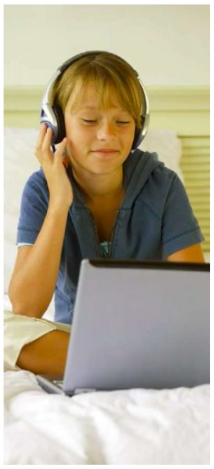
One of the most frequent uses of the Internet is communication. Email replaces traditional postal letters, or "snail mail," because it travels so much faster. A single message can be instantly sent to as many recipients as you want. If someone wants to respond to your email, they only have to click the reply button and then type out a message to send immediately back to you. You can also add attachments, such as photos, to your email.

The fact that some monkeys eat fruit is information you could find on the Internet.

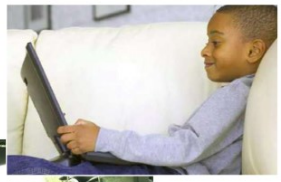
Answers to nearly any question can be found by searching the Internet. But with so much information available, how can you possibly find what you want?

The answer is to use a **search engine**—a tool that allows you to find the information you are looking for on the Internet. A search engine searches the contents of millions of webpages at the same time. All you have to do is go to a search engine website and type in one or more search terms, or keywords.

People also shop and pay bills on the Internet. You can view pictures of products you may want to buy. You can listen to music, purchase it, and then listen to the music on your computer. You can also purchase airline and entertainment tickets on the Internet. Some shopping websites let you bid on the products you want to purchase just as you would at an auction. Internet shopping has become so popular that in 2004, Americans spent an estimated 65 billion to 70 billion dollars through the Internet.



This girl listens through headphones to music on the Internet.



Students use websites on the Internet to practice reading and other skills.

Police officers use the Internet through computers in their cars to find out information about suspects.

Conclusion

The Internet has allowed computers all over the world to connect to one worldwide network for sharing information. It has changed the way we do business, communicate, and buy goods and services. The Internet will be even more influential as more people around the world connect to it from homes, schools, businesses, and through wireless connections. The future of the Internet is anyone's guess, but one thing is certain—how the Internet is used today will change tomorrow.

Explore More

On the Internet

1. In the address window of your browser, type *www.google.com.*
2. Type terms such as *Internet*, *Tim Berners-Lee*, or *ARPAnet* in the search window and click on "Google Search."
3. Read the colored links. Click on one that looks interesting. When you want to explore other links, click on the "back" button on your browser menu to return to the Google search page.
4. Try other searches, using words from something you are studying in school, words from your favorite activities, or even names of your favorite animals or book characters.

Glossary

bandwidth *(n.)* the maximum amount of information that can move on an Internet cable (p. 7)

bit *(n.)* the smallest amount of information that can be stored on a computer or sent over the Internet (p. 9)

broadband *(adj.)* high-speed (p. 10)

browser *(n.)* special Internet software for finding and looking at webpages (p. 11)

byte *(n.)* a unit of information that can be stored on a computer and is equal to one letter of the alphabet or one number (p. 9)

clients *(n.)* computers used by the general public to access all that the Internet provides (p. 13)

domain names *(n.)* the easily remembered identifications of websites that include extensions such as .com or .edu (p. 14)

fiber-optic *(adj.)* a type of cable made from thin strands of glass or plastic that can be used to carry signals (p. 6)

Internet *(n.)* a vast network of interconnected computers (p. 4)

IP address *(n.)* the number of a server or client computer (p. 14)

ISP *(n.)* stands for Internet Service Provider; companies that sell access to the Internet (p. 10)

modem *(n.)* a device used to connect a computer to the Internet (p. 10)

multimedia *(adj.)* relating to programs or files for pictures, video, and sound (p. 8)

search engine *(n.)* a search tool used to locate information on the Internet (p. 18)

server *(n.)* a computer that provides access to information or services on the Internet (p. 12)

URL *(n.)* stands for Uniform Resource Locator; the entire address used to access a website on the Internet (p. 11)

WiFi *(n.)* wireless network for sending information over the Internet (p. 6)

Index

Reading A-Z

Quick Check

LEVEL X

The Internet

Name _____ Date _____

Instructions: Read each question carefully and choose the best answer.

1. What is the difference between fiber-optic cable and wire cable?

Ⓐ Fiber-optic cable is slower and can't carry as much information as wire.

Ⓑ Fiber-optic cable is necessary to use the Internet, but wire cable is not.

Ⓒ Fiber-optic cable can carry computer signals, but wire cable cannot.

Ⓓ Fiber-optic cable can carry more information than wire cable.

2. What is a **modem**?

Ⓐ a device used to connect a computer to the Internet

Ⓑ the number of a server or client computer

Ⓒ the amount of information that travels on an Internet cable

Ⓓ all of the above

3. Which of the following is the main idea for the section "How Does the Internet Work"?

Ⓐ The Internet is used for communication.

Ⓑ The Internet began with hundreds of computers linked together in universities.

Ⓒ The Internet can be put into two groups called servers and clients.

Ⓓ The Internet is a permanently connected network of computers to which other computers can connect.

4. Why are IP addresses necessary?

Ⓐ to gather information about computer users

Ⓑ to distinguish one website from another

Ⓒ to keep certain people from accessing the Internet

Ⓓ to make sure that the computer users pay their bills

Quick Check continued on following page

Reading A-Z

Quick Check *(continued)*

LEVEL X

The Internet

Name _____ Date _____

5. What is the difference between clients and servers?

Ⓐ Clients provide a service to other clients.

Ⓑ Clients are necessary to use the Internet, but servers are not.

Ⓒ Clients are a series of numbers, and servers are a group of letters.

Ⓓ Clients don't provide a service, but they do send and receive information.

6. Which of the following is an opinion about the Internet?

Ⓐ Every computer has an IP address.

Ⓑ Internet Service Providers provide access to the Internet.

Ⓒ Information on the Internet is not reliable.

Ⓓ The Internet provides us with information.

7. What is a **search engine**?

Ⓐ a high-speed computer

Ⓑ a vast network of interconnected computers

Ⓒ a search tool used to locate information on the Internet

Ⓓ a GPS device attached to your car's engine

8. The Internet has become so popular because _____.

Ⓐ it transmits information over a long distance

Ⓑ it is able to send information very quickly

Ⓒ a computer user anywhere in the world can connect to it

Ⓓ all of the above

Quick Check continued on following page

Reading A-Z

Quick Check *(continued)*

LEVEL X

The Internet

Name _____ Date _____

9. How did Tim Berners-Lee help users of the Internet?

Ⓐ He started the first useable website.

Ⓑ He eliminated dangerous websites from the Internet.

Ⓒ He wrote a common language for computers to use.

Ⓓ He merged two large technology companies into one.

10. Which of the following is an important detail for the section "How Is Information Sent?"

Ⓐ Client computers don't provide a service.

Ⓑ The bandwidth of a cable allows information to move like cars on a highway.

Ⓒ The browser requests the website information.

Ⓓ Servers are computers that provide a service.

11. Extended Response: What do you think the author's purpose was for writing this book?

12. Extended Response: Explain in a sentence or two how the Internet is useful to you.

APPENDIX E: Reading Comprehension Pre-Test for Study 2

Written by Kira Freed
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Cover: This baby gray fox was found in a pipe on a farm. It will be placed with an adult fox before it is released into the wild.

Back cover: A rescued raccoon washes its food at a rehab center as it would in the wild.

Title page: Wildlife rehabber Lisa Bates works with a nearly blind hawk.

Wildlife Rescue
Level X Leveled Book
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Correlation

LEVEL X	
Fountas & Pinnell	S
Reading Recovery	40
DRA	40

Tucson Wildlife Center

Table of Contents

Who to Call?

If you see a wild animal in trouble, let an adult know right away. If you cannot find an adult you trust, look in the phone book under "Wildlife Rescue" or "Animal Rescue."

Introduction

A baby bird hops along the ground, and its parents are nowhere in sight. What should you do if you find a baby bird that appears to be orphaned? What if you discover a rabbit that seems unable to hop or a raccoon wobbling and swaying from side to side as it walks?

Many people don't know what actions to take, or not to take, when they find wildlife that may be in need of assistance. However, people with special training in caring for wildlife know just what to do. They know to leave the raccoon alone because it is probably sick, and they know whether they can help the rabbit and then return it to the wild. They can also look at the baby bird and determine what care to give, if any. These people can teach you how to help, too.

Topsy, a three-month-old female great horned owl, was rescued after she fell out of her nest during a windstorm. She is healing from neck and back injuries.

Wildlife Rehabilitators

People who help sick, injured, or orphaned wildlife are called *wildlife rehabilitators*, or "rehabbers." *Rehabilitate* means "to restore, or bring back, to good health." Wildlife rehabbers rescue wild animals and care for them as they heal. After the animals recover, rehabbers release them back into the wild whenever possible.

These wildlife rehabbers have special training in many areas. They are nutritionists with expertise in what and how much to feed different species of animals. They are behaviorists, meaning they have studied the behavior of wild animals and can understand and predict what a specific animal will do in various situations. They are animal-housing specialists who know exactly the type of cage, pen, or other enclosure to use for different species of animals, especially when an animal is injured and needs a particular kind of shelter to heal safely.

Animal caretakers treat a sea turtle for injuries to its right flipper.

Rehabber Lisa treats Tripod, a young javelina who was hit by a car.

Common Causes of Injury

• Hit by vehicles • Hitting other objects • Poisoning
• Illegal hunting • Litter and pollution • Animal attacks

Many rehabbers can treat wild animals with illnesses and injuries, too, just as **veterinarians** do. However, not all rehabbers are veterinarians, and not all veterinarians know how to care for wild animals. Most rehabbers specialize in the capture and transport of injured wildlife. Rehabbers know how to handle wildlife safely to prevent injury to the animals or themselves.

The work of rehabbers is needed more frequently as increasing numbers of people move into places where wild animals live. When land is used for farming, houses, and businesses, the natural habitats and foods of wild animals are destroyed, and animals are more likely to be orphaned, injured, or killed. People and their activities cause the majority of wildlife injuries.

Some wildlife rehabbers are generalists; they work with a variety of mammals, birds, and reptiles. Others are specialists, focusing in on just one group of animals, such as owls, bats, or ocean animals. Wildlife rehabbers often care for urban wildlife—animals that live in cities or towns, such as squirrels, raccoons, and foxes. Some courageous rehabbers work with dangerous animals such as bears, mountain lions, and bobcats.

Most wildlife rehabbers work with animals that are **indigenous**, or native to the region where the rehabbers work and live. They have special permits and licenses to treat these animals. To work with **exotic** animals, which are non-native animals that have migrated or been brought to the region, a rehabber requires special training with those animals as well as special licenses and permits.

A Florida state wildlife worker examines a panther kitten.

Many wildlife rehabilitation centers specialize in working with particular species, although they keep in contact with **colleagues** who specialize in other species in case a different kind of animal is brought in that needs help.

How do people become wildlife rehabbers? Many start as volunteers who learn how to care for animals in the homes and backyards of rehabbers with special wildlife training. Volunteers do not get paid for their work, but most rehabbers do not get paid, either. In fact, rehabbers often spend their own money to buy food, medicine, and shelters for the animals in their care. They are sometimes assisted by donations from people, businesses, and other organizations that also care about wildlife. People help wild animals because they care about animals and want them to get healthy. Rehabbers also recognize that proper care of wild animals promotes healthy habitats and prevents illness and injury to people as well.

A volunteer holds a baby red-tailed hawk while a rehabber takes off a bandage. The hawk broke a leg when it fell out of its nest.

Rescue

If you encounter an animal that may need rescuing, always follow these two rules: 1) *do not touch the animal,* and 2) *call an adult right away.* Adults can help by calling a wildlife rehabber who is trained in wildlife rescue. You can help by watching from a safe place to see where an animal hides so that rescuers can find the animal when they arrive. Putting a box or laundry basket over an injured small animal will protect it from predators until help arrives.

An animal rescuer gives water to a koala he saved from a fire.

Watch Out!

If you see any of these animal behaviors, stay away! They are clues that the animal may be sick—and dangerous.

- a bat on the ground
- a wild animal that appears to be tame
- an animal with excess drool, or what appears to be foam around its mouth
- an animal that can't move
- an animal that looks extremely angry
- a nocturnal animal (one that is normally active at night) that is active during the day—especially a raccoon, skunk, opossum, fox, or bat

SAFETY FIRST

. . . for Animals

- Animals may be injured or die from being held wrong when they are hurt and frightened.
- Animals may be injured or die if kept in the wrong kind of cage. For example, wild birds may break bones or damage feathers when trying to escape from wire cages.
- Human scent on a baby animal may cause its parents not to care for it. This is truer for mammals than for birds because mammals have a better sense of smell.

. . . for People

- Injured wild animals may be frightened because they are in pain. They may bite, kick, scratch, peck, or stab to try to defend themselves. They don't know that people are trying to help.
- Wild animals may have diseases that can be passed on to humans and pets. Bats, coyotes, raccoons, foxes, and skunks are more likely than other wild animals to carry rabies, a deadly disease that all warm-blooded animals, including humans, can catch. Anyone who may have been exposed to rabies must be treated right away.

Many baby animals are wrongly, and sometimes tragically, taken from their homes when they aren't in danger. A baby bird hopping on the ground may not be orphaned—it might be a **fledgling**, a young bird learning how to fly. Fledglings often hop on the ground to practice moving before they fly. The parents of these baby birds usually watch them, though the parents might not be visible to people.

People sometimes think they are rescuing baby rabbits, seals, and deer when these animals aren't in trouble. It's normal for babies of these species to rest quietly on a beach or in the grass while their mothers eat nearby. Only people trained in the natural ways of these animals know whether the babies need human assistance; if they don't, taking them from their mother hurts their chance of survival.

Unless baby animals are wounded, they do not need to be rescued.

Many people wrongly believe they are helping wild animals by taking them home. Don't confuse loving wildlife with being able to take care of these animals. Much more training is needed to care for wild animals than to care for dogs and cats—and besides, taking home wild animals is against the law. If you were injured in an accident, would you want just anyone taking you home and caring for you? No, you would want someone trained to help, such as a doctor or nurse. You would also want to be taken to a clean place that had the right equipment and medicine to help you. Like you, wild animals deserve the best care available.

Veterinarians examine a red panda.

Do You Know?

Spring is the busiest time of year for wildlife rescue because wild animals give birth in the spring. Babies are weaker and often can't survive on their own. A baby animal may become orphaned if a car hits its mother or if a hunter or predator kills its parents.

Rehabilitation

When animals are brought to a rehabilitation center, the first step is to give them a checkup and first aid. Newly rescued animals are **quarantined**, or put in their own cages, so that they do not infect other animals. Rehabbers keep detailed notes about each animal so they can tell if the animal is getting better, when to give it medicine, and when to feed it.

Animals that come to rehabilitation centers can have a wide variety of problems. If they have broken bones or diseases, veterinarians must treat those problems first; afterward the animals can go to the rehabilitation center to get well.

Igor, a black vulture, was fed birdseed instead of the meat he needed for good health. His bones became fragile and broke during his rescue.

Animals may need to heal in one place and recover in another place. For example, a hawk with a broken wing might first need a small, dark cage where it can stay calm while it starts to heal. After the broken bone has healed, the hawk might need to move to an outdoor area called a *flight cage*, where it can exercise and relearn how to fly.

Rehabilitated birds practice flying in a flight cage until they have healed enough to be released.

Young, injured animals often need additional care so they can heal, and as they become stronger, they may be placed with an adult animal to help them. Adult animals show younger animals useful behaviors and how to hunt for food properly.

Infant animals need special care because they need to stay warm. Rehabbers may put them in an **incubator** to keep them warm, or the rehabbers may place hot-water bottles, heating pads, or lightbulbs in cages.

Most wild animals are frightened of people, and being away from home is stressful. Too much stress can kill a wild animal. Workers at rehabilitation centers try to protect animals from excessive contact with people by keeping noise levels low and covering cages with towels, among other techniques. They also refrain from staring at the animals because, in the wild, staring sends a signal that an animal is being hunted.

A puppet serves as a substitute mother so that this young condor doesn't get too used to humans.

Imprinting

Baby animals imprint on their mothers at an early age; a baby duck learns that it is a duck by watching its mother every day. Wildlife rehabbers take special care not to let baby birds imprint on people; otherwise, the babies will grow up thinking they are human and will seek out humans instead of their own kind. Raptors, or birds of prey, and other birds that have imprinted on people may become dangerous in the wild. They may seek attention from a hiker who doesn't know they are used to human contact. The hiker or the bird could get hurt in the meeting. For this reason, the birds often cannot go back to the wild.

A volunteer feeds a mouse to an adult red-tailed hawk that is almost completely blind.

Do You Know?

Meat-eating animals at rehabilitation centers need to eat meat so that they heal and grow strong. Wildlife rehabbers pick up animals recently hit by cars or trucks along roads, called *roadkill*, to use as animal food. They also keep freezers full of "mouse-cicles"—frozen mice that they use as food. To save money, some centers raise quail, mice, rats, and rabbits as animal food.

Wildlife rehabbers must feed each animal its natural foods or something similar because some foods can make the animals sick and hinder their normal growth. For example, cow's milk is extremely harmful to many baby animals and can even kill them.

Rescued animals must be fed natural foods so that they can survive in the wild later on. Natural foods are most important for orphaned animals that have grown up in a rehabilitation center. If they develop a taste for human food or do not learn to hunt or **forage** on their own, they might starve after being released in the wild.

Release

When a rescued animal is ready to return to the wild, rehabbers must decide where to release it. The search for an appropriate location begins long before an animal is ready for release. Knowledge of an animal's natural history is essential for a rehabber, who must evaluate a potential habitat based on the requirements of the specific animal and the qualities of the location. Rehabbers find an area that has plentiful sources of food, water, and shelter, and they make sure the area is safe from human contact.

Rehabbers must also be certain the animal is healthy enough before releasing it—that it can run, climb, swim, or fly without difficulty. They also make sure the animal is able to see, hear, locate food, avoid predators, and be social with other animals of its own kind. When releasing an animal, a rehabber will often request assistance from a wildlife biologist or **ornithologist** to make sure the process goes smoothly.

This Tasmanian devil will be examined before it's released.

The first step in releasing an animal is moving it to an outdoor pen or cage with other animals of the same kind. Once outdoors, the animal can get used to the weather and to less-frequent contact with humans until the animal is ready for release.

Slow release is often used with young animals, especially orphans. Rehabbers put a pen in a safe place in the wild with the door left open so that the animal can return to it. Rehabbers provide food for the animal until it is clear that the animal can find food for itself. Fast release is often used with wild animals rescued as adults. These animals already know how to live on their own in nature. They are taken to a release location, ideally near where they were found, and are let go.

A wildlife rehabber has some company as she lets this bald eagle fly.

About half the animals at rehabilitation centers are too sick or too badly injured to ever be released back to the wild. Many animals have lost limbs, beaks, wings, or eyesight. A bird with an injured wing that does not heal properly, or with only one eye, would not be able to fly or hunt in the wild.

When it is clear that an animal will never survive in the wild or at a rehabilitation center, rehabbers have to make a difficult decision. If the animal is in pain, euthanasia—quick, painless killing—is sometimes the best way to end that animal's suffering.

This adult female great horned owl is not a quiet flyer because of a wing injury. The noise warns prey animals she hunts, so she can never be released.

Disaster Rescue

Human activities are not the only causes of wildlife injuries. Natural disasters, such as wildfires, tsunamis, and hurricanes, hurt animals, too. Terri Crisp spends much of her time rescuing animals that are affected by natural disasters.

Terri Crisp with one of the animals she has rescued from earthquakes, fires, floods, hurricanes, oil spills, tornadoes, and other disasters

During a raging California wildfire in 1986, Terri rescued a Shetland pony by **coaxing** it into a car. She worked to save sea otters and loons in 1989 during the *Exxon Valdez* oil spill in Alaska, and in 1992, she worked to rescue hundreds of animals hurt by Hurricane Andrew. She founded the organization Noah's Wish to train volunteers to rescue animals that are at risk because of disasters.

Incredibly, many wild animals knew to run inland before the 2004 Asian tsunami hit land; however, pets and farm animals did not fare so well. Several people in the areas hit by the tsunami depended on working farm animals; many of these animals were killed, injured, or left in **devastated** areas without food. The Humane Society International worked with other organizations and volunteers to help the animals—and the people who cared for them—get their lives back on track.

A man carries his daughter and dog to safety after the tsunami in December 2004.

Conclusion

Rehabbers often use animals that cannot return to the wild as **ambassadors** to help teach people to respect wildlife. Children and adults learn about wildlife that live in their local area and about respecting habitats so that wild animals can continue to find food and shelter.

Wildlife rehabbers do important work in caring for injured wild animals and returning many of them to the wild. You can help rehabbers' efforts by respecting wildlife and by calling a rehabber if you see an animal in distress. One phone call might give a wild animal the opportunity to grow up and live a free and healthy life.

This bird of prey acts as an ambassador to teach children about animals in their area.

Glossary

ambassadors *(n.)* representatives of a country, species, or cause (p. 22)

coaxing *(v.)* convincing through gentle persuasion (p. 20)

colleagues *(n.)* people who do a similar kind of work (p. 8)

devastated *(adj.)* destroyed by violent force (p. 21)

exotic *(adj.)* from a different place, often far away (p. 7)

fledgling *(n.)* a young bird that is learning to fly (p. 11)

forage *(v.)* to search for or gather food (p. 16)

incubator *(n.)* an enclosure in which a baby animal is placed to keep it warm (p. 14)

indigenous *(adj.)* native to a particular place (p. 7)

ornithologist *(n.)* a scientist who studies birds (p. 17)

quarantined *(v.)* isolated to prevent the spread of disease (p. 13)

veterinarians *(n.)* doctors who treat animals other than humans for illnesses and injuries (p. 6)

Index

Reading a-z

LEVEL X

Quick Check

Wildlife Rescue

Name _____ Date _____

Instructions: Read each question carefully and choose the best answer.

1. The author's purpose is _____.
   - (a) to persuade
   - (b) to inform
   - (c) to entertain
   - (d) to describe a process
2. **Rehabilitate** means _____.
   - (a) to return to nature
   - (b) to feed
   - (c) to restore to health
   - (d) to take to a zoo
3. What issue does this book address?
   - (a) Many injured or sick animals are in need of expert help.
   - (b) Children should learn how to rehab injured wild animals.
   - (c) Too many animals get injured each spring.
   - (d) Knowledge of proper care of wildlife is not necessary to help them.
4. Rehabbers address the _____ needs of injured or sick animals.
   - (a) nutritional
   - (b) health
   - (c) housing
   - (d) all of the above
5. Rehabbers mostly help animals that have been injured by _____.
   - (a) other animals
   - (b) people and their activities
   - (c) dangerous weather conditions
   - (d) starvation
6. *Rehabbers often work with animals **indigenous** to the region where they live.* What does **indigenous** mean?
   - (a) extinct
   - (b) common
   - (c) native
   - (d) dangerous

Quick Check continued on following page

Reading a-z

LEVEL X

Quick Check *(continued)*

Wildlife Rescue

Name _____ Date _____

7. Why is it a bad idea for an untrained person to try to help an injured or sick animal?
   - (a) The animal might have a dangerous disease.
   - (b) The person might accidentally hurt the animal.
   - (c) The animal might be aggressive because it is frightened.
   - (d) All of the above
8. If you see an infant animal that's all alone, _____.
   - (a) you should not disturb it
   - (b) the infant animal's parents are probably eating nearby
   - (c) the infant animal's parents may be watching you
   - (d) all of the above
9. Why should you not take an injured wild animal home?
   - (a) The animal might not be suited to your home environment.
   - (b) Taking wild animals home is illegal.
   - (c) Injured wild animals need trained help.
   - (d) All of the above
10. A **quarantined** animal _____.
    - (a) must be killed
    - (b) is caged away from other animals
    - (c) cannot be rehabbed
    - (d) shares cage space with other animals
11. Adult animals help younger rehabbing animals _____.
    - (a) by teaching correct behaviors and hunting skills
    - (b) escape from cages and return to the wild
    - (c) by cuddling with them so they aren't lonely
    - (d) by giving them their food

Quick Check continued on following page

Reading a-z

LEVEL X

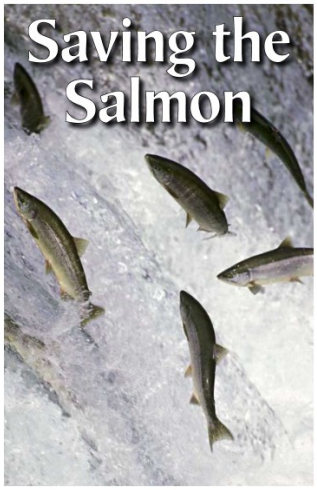
Quick Check *(continued)*

Wildlife Rescue

Name _____ Date _____

12. When can an animal not be released back into the wild?
    - (a) when the animal doesn't want to go
    - (b) when rehabbers get too attached to the animal
    - (c) when the animal will not be able to survive on its own in the wild
    - (d) when rehabbers aren't sure where the animal used to live
13. **Extended Response:** What skills should a rehabber have? Name at least three.
14. **Extended Response:** You find an injured deer in the woods. Describe the steps you should (and shouldn't) take.

APPENDIX F: Reading Comprehension Post-Test



Written by Karen Mockler

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Front cover: The Adams River in British Columbia has one of the largest sockeye salmon runs in North America.

Back cover: A salmon "climbs" a fish ladder on Oregon's Rogue River.

Saving the Salmon
Level X Leveled Book
© Learning A–Z
Written by Karen Mockler

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Correlation

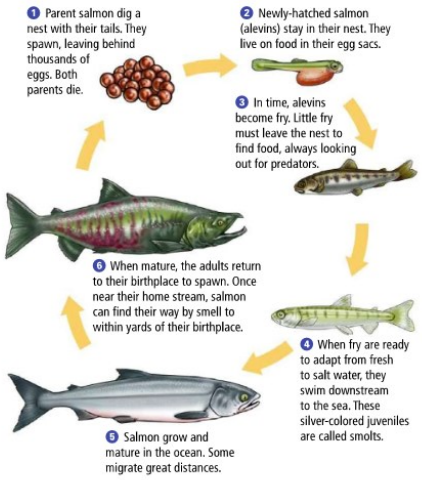
LEVEL X	
Fountas & Pinnell	S
Reading Recovery	40
DRA	40

Table of Contents

Introduction

Salmon know how to travel. They don't live a long time by human standards—only a few years. But during that time, they make a more epic journey than most of us ever will.

Salmon Life Cycle



Both Pacific and Atlantic salmon are born in fresh water. They make their way to the open ocean to grow up. Very few creatures are able to live in both salt water and fresh water. Fewer still can **migrate** 3,000 miles through the ocean, then as many as 1,000 miles upstream, in order to reach the exact spot where they once hatched.

To get home, salmon have to make it past fishing nets, sea lions, dams, and more. It is a long, hard, and desperate race. Only one out of a thousand salmon may make it back to the stream where it was born. Salmon do all of this just to **spawn** and then die.

Yet salmon in many U.S. rivers are dying before they spawn because of changes that people have made to those rivers. Some of the biggest changes—and biggest challenges to salmon survival—are on the Columbia River in the Pacific Northwest.

A sea lion catches a Chinook salmon migrating up the Columbia River. Many wild animals, from tiny insects to grizzly bears, depend on salmon for food.

The Mighty Columbia

The Columbia River is the biggest river flowing into the Pacific Ocean from North America. It drains a 259,000-square-mile basin—roughly the size of France—that includes land in seven Western states. It begins in the Canadian Rockies of British Columbia, and its **tributaries** come from as far east as Yellowstone National Park. The river's last 300 miles form the Washington–Oregon state line.

Fishermen unload their nets of salmon on a pier a century ago.

At one time, six **species** of Pacific salmon are known to have lived in the Columbia River Basin: Chinook, coho, sockeye, chum, pink, and steelhead. Five of the six species are still found there. Pinks are **extinct** in that river, and scientists worry that others may die off, too.

Legend has it salmon once were so thick in some Columbia tributaries that you could cross from one riverbank to the other by walking on their backs. In the 1850s, Washington settlers said two men with a boat and a net could catch 1,200 pounds of salmon in one night. At that time, some 10–16 million adult salmon returned to the Columbia each year to spawn. Today, a tiny fraction of that number return. What happened?

Settlers and Salmon

Native Americans of the Columbia River Basin lived on and *with* the salmon for thousands of years. White settlers did things differently than the Indian tribes. As soon as the settlers arrived, they began to change the salmon's habitat, always in ways that hurt salmon.

First, they removed giant clusters of logs from the rivers that salmon had long relied on for shade and protection. Next, the settlers started logging the forests, which in turn sent dirt into the rivers. Salmon need clear, cool, rocky beds to lay their eggs in. The dirt choked and destroyed their spawning beds. Later, the invention of the chainsaw and bulldozer let people log the forests faster, only making matters worse.

Three loggers pose atop giant trees in 1905.

Engraving of an 1880s illustration of a salmon cannery in Astoria, Oregon, at the mouth of the Columbia River

Farmers' widespread use of pesticides and fertilizers to keep insects away and grow bigger crops polluted the water. **Irrigation** for crops took water from streams and left little for fish.

Fishing—or rather, overfishing—hurt Pacific salmon, too. When a type of fish is taken so often and in such great numbers that there aren't many left, that fish can go extinct. Once the canneries were built, they could preserve the fish for longer travel. That meant fishermen could catch as many fish as their nets could hold without fear of their spoiling before they were sold. Canned salmon was shipped everywhere.

By the 1860s, fishermen caught millions of pounds of fish each year, especially salmon. The Chinook salmon taken from the Columbia peaked in 1883 at almost 43 million pounds. But in the 1900s, those numbers began to drop. Then the dams arrived.

The Rise of Dams

Today, dams are the greatest threat to salmon survival. Fishing—both ocean and in-river—kills far fewer salmon. The dams have destroyed thousands of fishing jobs by killing millions of fish.

One hundred years ago, there were no dams on the Columbia. Today the main stem of the river has fourteen dams, with three in Canada and eleven in the United States. Including its tributaries, the river system holds more than 400 dams. Some produce **hydroelectric power**; some do not. Some are humble in size; others are huge.

More than anything else, these dams have caused the salmon's decline. Here's why: During their life cycle, salmon have to travel downstream as **juveniles** and return upstream as adults. Dams work against salmon swimming in either direction.

H is for Humans

Do You Know?

Today salmon are at risk for a variety of reasons, but the biggest ones can be broken into three categories. All begin with H: habitat (the decline of the salmon's home), harvest (overfishing), and hydroelectric power (dams). In each case, humans are responsible.

Ladders for Fish?

By leaping up a series of low steps, adult fish are able to climb past the dams. The amount of water falling over the steps has to be enough to attract the fish to the ladder. But it can't be so much that it washes fish back downstream or exhausts them so that they can't continue their journey upriver.

The obvious problem is the dam itself. Adult salmon returning upstream have to find a way past each dam that stands between them and their birthplace. When engineers built the dams, they built many with fish ladders so adults could return to spawn where they were born. Fish ladders are a great invention, but some salmon fail to find them. Others fall back down from above the dams.

The less obvious—but worse—problem caused by each dam is the water backed up behind it. Where a river once ran, each dam creates a **reservoir** in its place.

Salmon understand how to navigate rivers because the water in creeks and rivers is always moving downstream. Adults heading upstream lose their way in the reservoirs because the water is slack—it has no current for them to follow. Juveniles coming downstream have it far worse. During their journey to the ocean, juveniles used to get a big boost when they were washed downstream by spring snowmelt. Since reservoirs have replaced the river behind dams, what once was a week's trip to the ocean now takes thirty days. As fish drift without a current, some fall ill and die. Others are caught in the dams' turbines.

These reservoirs also breed **predators**. Although native to the Columbia, pikeminnow love the still, warmer water created by dams. So do certain non-native fish. Both groups have a taste for juvenile salmon. In one reservoir alone, these fish are estimated to eat 2.7 million juvenile salmon each year, with pikeminnow taking most of them.

The dams kill far more juvenile salmon migrating to the ocean than adults migrating from it. Of course, there are more young salmon to kill. The ones that never make it to the ocean will never make it back again.

Spending to Help Salmon

People want to save the salmon. Just in the five years between 1997 and 2001, federal, state, and Native American governments spent $1.5 billion on efforts to save the salmon. Programs are in place to control water pollution, overfishing, and mobs of pikeminnow as well as to promote healthy salmon habitat. People even give barge rides to juvenile salmon headed downstream.

Here's how barging works: At certain dams, the government collects millions of juveniles out of the river. The young fish are shot through pipes into barges (boats with flat bottoms) that carry them downstream. Below the last dam, the government dumps them back in the river.

Thousands of young steelhead salmon are released to start their journey to the ocean.

By 2005, upwards of 90 percent of the juvenile salmon in the Snake River—the Columbia's largest tributary—were barged. That number has dropped to less than 50 percent since 2006. Why? Because it turns out that salmon barged below the dams die at a greater rate than those that make their own way through the dam system.

Instead, some dams have been spilling extra water to help the juveniles downstream. When water spills over the dams, fish spill, too. That means fewer fish are collected, and fewer are barged. Spilling water for salmon means less water for hydroelectric power. But sending fish over the dams instead of around them actually gives juveniles a higher rate of survival.

Just as barging once seemed like a great idea, Congress funds **hatcheries**—at a cost of $80 million a year—to breed and raise fish. When the fish are old enough, they're released into rivers. The goal is to replace the miles of salmon spawning grounds that were blocked or flooded behind dams.

Hatcheries multiply the number of salmon born each year. What's more, because there are no predators in hatcheries and food is easy to come by, more young salmon survive in the hatchery than would in the wild. But hatcheries create their own set of problems.

How a Hatchery Works

People capture salmon returning to spawn in hatcheries or in rivers and streams. They collect the salmons' eggs and watch over them. Once the eggs hatch, people place them in holding tanks to grow and develop. When the fish are old enough, they are released into the river. If they make it to the ocean, they'll spend the next 1–3 years there, then return to the hatchery or spawning grounds.

For starters, hatchery fish aren't considered truly wild. Because their early lives are easier than those of salmon spawned naturally, they're less fit, less experienced, and therefore less apt to survive compared to wild fish. They're also more prone to illness. Maybe worse, they compete with wild salmon and even prey on them. Scientists still question whether hatchery programs help or threaten the survival of wild salmon. And some people argue that hatching more fish just throws millions more into a system that could end up killing them.

Critics say that the steps being taken to keep Columbia River salmon alive have grown as unnatural as the changes to their habitat. Maybe worse, critics say these steps don't solve the root problem. The real problem, they argue, is the dams.

Tourists on a paddle wheel riverboat wait to move upriver as the lock fills at Bonneville Lock and Dam on the Columbia River.

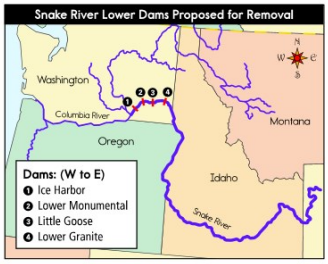
What's So Great About Dams?

The dams were built for a reason, of course. Dams do a lot of great things. They allow the passage of ships and help control floods. These are problems that the first settlers in the Northwest were forced to face many times. Thanks to the dams, more inland areas can send their products (such as wheat and paper) down the river to seaports and beyond. Other products can make their way upstream.

Dams provide water for one of the largest irrigation projects in the western United States. The project sends water to over half a million acres of rich but dry lands in central Washington. Thanks to the river water, the area's farms grow important crops such as apples, corn, potatoes, hops, beans, and sugar beets.

When Bonneville Dam was built in the 1930s, the dam was a disaster for Native Americans who lived upstream. Others welcomed the cheap electricity that the dam helps provide.

The Columbia is a great source of hydroelectric power as well. The fourteen hydroelectric dams on the Columbia and the many more on its tributaries generate more hydroelectric power than those on any other North American river. Today, customers in the Pacific Northwest enjoy some of the cheapest electricity in the country, as do high-tech companies like Google. The dams don't pollute or contribute to global warming either, but all these benefits come at a price. Much of that price has been paid by salmon, which have been driven to the point of extinction.



Taking Down Dams

Since the salmon have been listed as endangered species, pressure to do something about the dams has grown. Spilling water has helped salmon, but people still talk about taking out dams—maybe not all of them, maybe not most of them, but some. The dams that seem to generate the most talk are four on the Snake River. Together, those four dams create one long stretch of slack water for about 140 miles. That water makes it tough for salmon to migrate both upstream and downstream. Scientists say that allowing the lower Snake River to flow naturally is the best way to bring back the salmon.

Dam removal is not unheard of, especially in the Pacific Northwest. Marmot Dam on Oregon's Sandy River was removed in 2007, making it a free-flowing river from Mount Hood glaciers to its mouth at the Columbia River for the first time in ninety-five years.

Taking down the dams is pretty simple. The reservoirs would be drained; the rivers would run again. But removing those four dams worries people in the area for a number of reasons.

Members of the environmental group "Save Our Wild Salmon" gather at Bonneville Dam in 2004.

They fear the loss of cheap power to the Pacific Northwest. They fear that the lost power would be replaced by forms of energy that would worsen air pollution and global warming. They fear that removing those dams would hurt the area's economy and its farmers, leading to thousands of lost jobs.

Are they right to be afraid?

People who want to remove the dams don't think so. They say that with careful planning, electricity bills, pollution, and spending on saving the salmon can all actually come down along with the dams. They explain that removing the dams can lead to new jobs. They explain how farmers can find other ways to get their crops to market and other ways to get water for irrigation as well. The two sides argue back and forth.

What Does "Endangered" Get You?

Meanwhile, scientists have known for decades that the Pacific Northwest's salmon are in trouble. Every type left in the Columbia River Basin is listed for protection under the Endangered Species Act and has been for years.

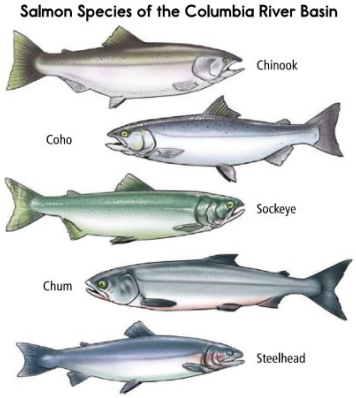
One of the most important ways the Act can protect species is by protecting their habitat, since a species cannot survive without a home. But the habitat of Columbia River salmon underwent huge changes before the fish were ever listed for protection. So while some argue about how to protect the salmon's habitat, others insist that the real question ought to be how to *restore* it.

Save That Species!

Endangered species are plants and animals that exist in small numbers and may be lost forever without quick action to stop their decline. In 1973, Congress passed the Endangered Species Act (ESA) to protect those animals most in danger of extinction in the United States. The Endangered Species Act says people must act on the "best available science" in order to save those species. It can be a powerful law to have in your corner.

Thanks to the ESA, the bald eagle and other species have been saved.

Salmon Species of the Columbia River Basin



According to scientists, the best course of action to save the salmon is to take out some dams. According to the Endangered Species Act, if the best science says dams should come down, then dams should come down. But when money and politics are involved, science sometimes gets pushed aside. When that happens, species like the salmon get pushed aside, too.

Conclusion

Some people say it's a waste of time to talk about whether to pull down the dams. They say most people don't care enough about the fish to tear them down.

So far, this seems to be the case. And so far, a few salmon still make it back to the bend in the river where they were born. They lay their eggs before they die so their whole amazing story can begin again.

So far, salmon remain a living legend. If people care enough, salmon can stay that way, instead of becoming the sort of legend that starts, "Once upon a time."

Glossary

extinct *(adj.)* no longer in existence; completely wiped out (p. 7)

hatcheries *(n.)* places where animals are raised from eggs (p. 14)

hydroelectric power *(n.)* electricity produced when moving water turns turbines that are connected to generators (p. 10)

irrigation *(n.)* the practice of supplying water to land or crops to promote growth (p. 9)

juveniles *(n.)* young people or other animals that have not reached maturity (p. 10)

migrate *(v.)* to move from one habitat or region to another at a certain time each year (p. 5)

native *(adj.)* natural to an area (p. 8)

predators *(n.)* animals that hunt and eat other animals to survive (p. 12)

reservoir *(n.)* a large tank or lake used for collecting and storing water for human consumption or agricultural use (p. 11)

spawn *(v.)* to make and lay eggs (p. 5)

species *(n.)* a group of living things that are physically similar and can reproduce (p. 7)

tributaries *(n.)* rivers or streams that flow into a larger river (p. 6)

Reading a-z

LEVEL X

Quick Check

Saving the Salmon

Name _____ Date _____

Instructions: Read each question carefully and choose the best answer.

1. What makes salmon a unique type of fish?
   - Ⓐ They live in both fresh and salt water.
   - Ⓑ They are found in the Atlantic Ocean.
   - Ⓒ They swim downstream to spawn.
   - Ⓓ All of the above
2. Which of the following is the author's point of view about salmon?
   - Ⓐ Natural river flow is not necessary to help increase salmon population.
   - Ⓑ The Endangered Species Act will save all the salmon.
   - Ⓒ Action should take place to save the salmon.
   - Ⓓ Dams are too important to the economy to remove.
3. If an animal is **extinct**, it is _____.
   - Ⓐ no longer in existence
   - Ⓑ spawning
   - Ⓒ able to swim upstream
   - Ⓓ introduced to an area
4. Which of the following is an opinion?
   - Ⓐ Salmon swim thousands of miles during their lifetime.
   - Ⓑ Humans are solely responsible for the decline of salmon species.
   - Ⓒ Taking down dams is a simple process.
   - Ⓓ Dams generate hydroelectric power for thousands of people.
5. What is the main cause of the salmon decline along the Columbia River?
   - Ⓐ boats in the river
   - Ⓑ predators
   - Ⓒ hydroelectric dams
   - Ⓓ all of the above

Quick Check continued on following page

Reading a-z

LEVEL X

Quick Check *(continued)*

Saving the Salmon

Name _____ Date _____

6. Early white settlers caused negative effects to the salmon habitat by _____.
   - Ⓐ logging along the river
   - Ⓑ fishing too much
   - Ⓒ farming and irrigating from the river
   - Ⓓ all of the above
7. Where do wild Pacific Northwest salmon begin their lives?
   - Ⓐ in fresh water
   - Ⓑ in the ocean
   - Ⓒ in dams
   - Ⓓ in reservoirs
8. A place where fish are raised from eggs is called a _____.
   - Ⓐ hatchery
   - Ⓑ reservoir
   - Ⓒ tributary
   - Ⓓ pond
9. The author wrote this book to _____.
   - Ⓐ let readers know about the Columbia River and its tributaries
   - Ⓑ entertain readers with photos of early settlers in the Pacific Northwest
   - Ⓒ inform readers about the endangerment of salmon on the Columbia River
   - Ⓓ persuade readers to stop eating salmon
10. When animals **migrate**, they change their _____.
    - Ⓐ mate
    - Ⓑ habitat
    - Ⓒ color
    - Ⓓ none of the above
11. **Extended Response:** How do you think the salmon populations along the Columbia River can be restored?
12. **Extended Response:** Do you think the needs of humans are more important than the needs of animals? Explain.

APPENDIX G: Research Guide from Study 1

Research Questions

BIG Research Question

(What are you setting out to discover?): _____

_____

_____

_____

Research Sub-Questions

(What other questions come up as you research?)

_____

_____

_____

_____

_____

_____

_____

_____

My Published Contributions

REQUIRED Notes:

☑	Scaffold	Title	Date
	I Need to Understand		
	New Information		
	New Information		
	New Information		
	My Theory		

More Published Notes:

☑	Scaffold	Title	Date

Ah-Hah! Moments

On _____(date), we put our knowledge together to figure out that _____

_____

_____

On _____(date), we finally realized that _____

_____

_____

On _____(date), we found out that _____

_____

_____

Our most important discovery is: _____

_____

Research Guide: Books

Research Question: I need to understand _____

_____

_____

Title: _____

Author: _____ Page #_____

New Information:

Title: _____

Author: _____ Page #_____

New Information:

Title: _____

Author: _____ Page #_____

New Information:

I think _____

_____

_____

_____

_____

Research Guide: Internet

Research Question: I need to understand _____

_____

_____

Title: _____

http:// _____

New Information:

Title: _____

http:// _____

New Information:

Title: _____

http:// _____

New Information:

I think _____

_____

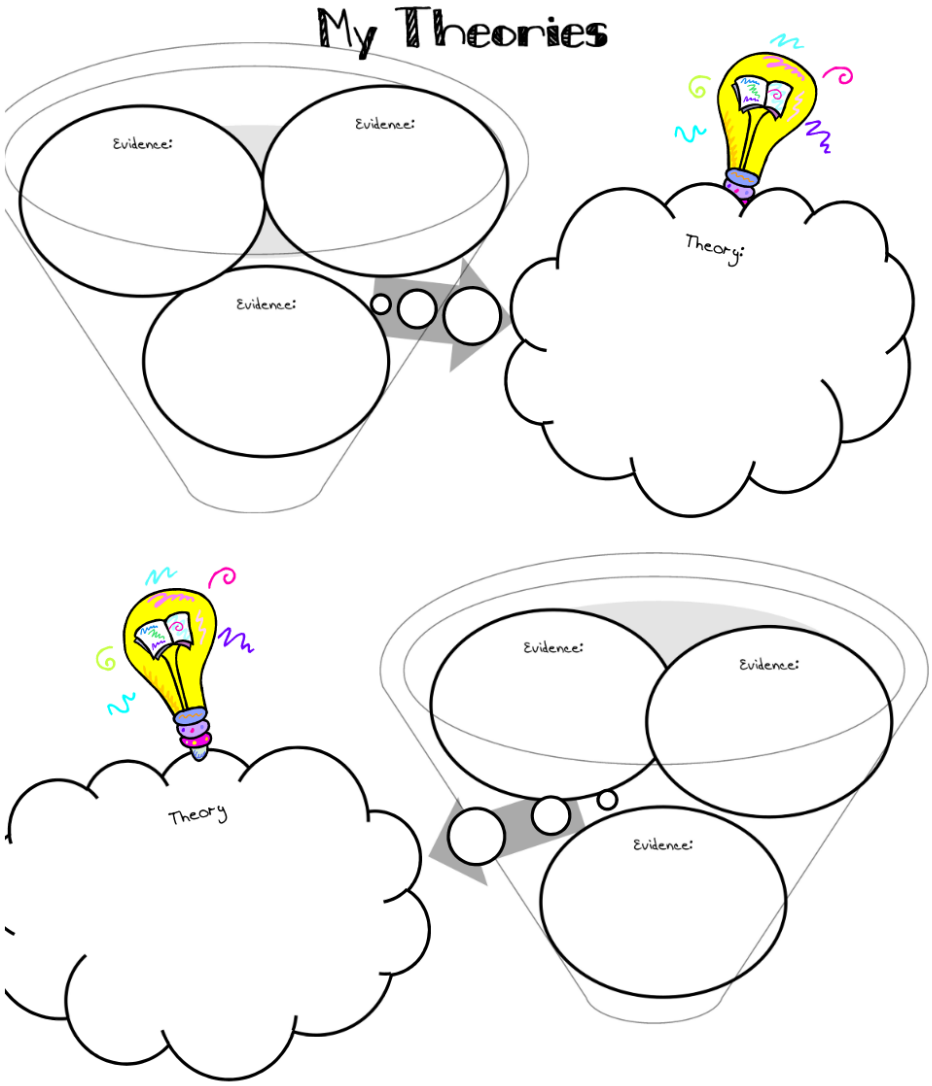
_____

_____

_____

People Resources (at least 1)

Person	New Information	Date


My Theories
Evidence:
Evidence:
Evidence:
Theory:
Theory
Evidence:
Evidence:
Evidence:

Book References (at least 3)

Sample:

Scott, Susan. Exploring Hanauma Bay. Honolulu:
University of Hawaii Press, 1993.

(Author. Title of Book. Edition. City of Publication: Publisher, Year.)

Internet References (at least 3)

Sample:

Encyclopedia Mythica. 2004. <http://www.pantheon.org> .

Title of the Site. Date and/or Version Number (if available). <URL>.

Mon	*Tue*	*Wed*	*Thu*	*Fri*
ML: Minilesson topic **KF: Knowledge Forum** **RC: Reading Conference (Student ID #s)**		**Dec. 12-ML:** Choosing Just Right Books / Stop & Jots (anchor chart)	**13-ML:** Modeling reading nonfiction text features **RC: (**3, 14) (8, 22)	**14-ML:** Introduced stop & jots, new books, modeled KF **RC: (**10, 17)
17-ML: Writing post-its (gold, silver, bronze) **RC: (**18, 13)	**18-ML:** Organizing post-its **RC: (**5, 17) (6, 8, 12) (7, 21) (5, 19)	**19-ML:** Research groups **RC: (**19, 20) (1, 18)	**20-ML:** Main idea & details	**21-ML:** (none) **RC: (**4, 16)
Winter Vacation: **December 24—January 1**		**Jan 2-ML:** partner discussions **RC:** (5, 11, 14)	**3-ML:** using discussion board **RC: (**1, 13) (17, 6, 24)	**4-ML:** parts of nonfiction **RC: (**24, 6) (1, 7, 13, 21)
7-ML: main idea & details **RC: (**12, 17, 22)	**8-ML:** KF checklist, logins **KF:** 6 students **RC: (**4, 3, 2)	**9-ML:** narrative nonfiction **KF**: 5 students **RC: (**10, 8, 24) (21, 7, 18)	**10-ML:** big ideas **KF:** 5 students **RC: (**2, 17) (1, 6)	**11-ML:** discussing big ideas **KF:** 5 students **RC: (**11, 14, 5)(23, 15, 13, 8)
January 14 Holiday No School	**15-ML:** cause & effect **KF:** history group **RC:** no video data (1, 3, 13) (7, 21) (5, 11, 14)	**16-ML:** using journal to post on Knowledge Forum **KF:** 1/2 food chains/animals **RC:** (22) (23)	**17-ML** picking just right book **KF:** 1/2 food chains/animals **RC: (**18, 15, 6) (6, 12, 24) (20, 19)	January 18 Field Trip
21-ML: (none) **KF:** whole class on iPads **RC:** (3, 15, 18) on iPads	**22-ML:** getting "pulled in" to nonfiction **KF:** planets group **RC:** (2, 16) (13, 23, 10)	**23-ML:** modeling KF **KF:** (requested) chemistry, food chains / animals **RC: (**4, 6, 12, 8, 17) (23, 16, 10, 22)	**24-ML:** writing response w/ ideas, evidence, connections **KF:** 11, 14, 13 1, 18 **RC:** (4, 8, 23, 1, 22, 24) *no video data*	**25-ML:** (none) **C:** (22) (1, 21, 20, 7)
26-ML: narr. nonfiction **KF:** chemistry group **RC:** (none) TC assessments	**27-ML:** narr.nonfiction **KF:** history group **RC:** (none) TC assessments	**28-ML:** narrative nonfiction **KF:** 3, 1, 7, 15, 21 **RC:** (none) TC assessments	**29-ML:** narr.nonfiction **RC:** (none) TC assessments	