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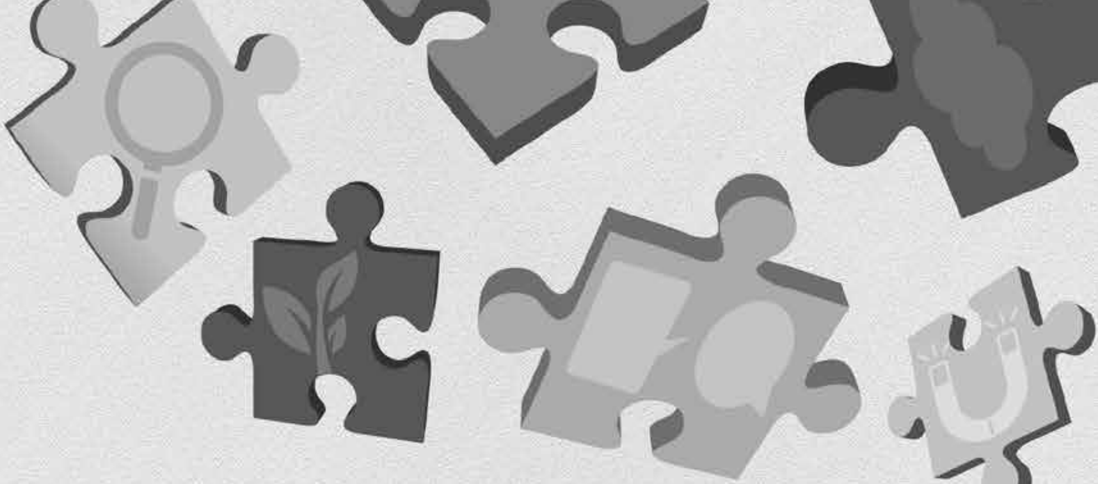
Three-Dimensional Investigations

Victor Sampson and Ashley Murphy

NSTA press
National Science Teachers Association



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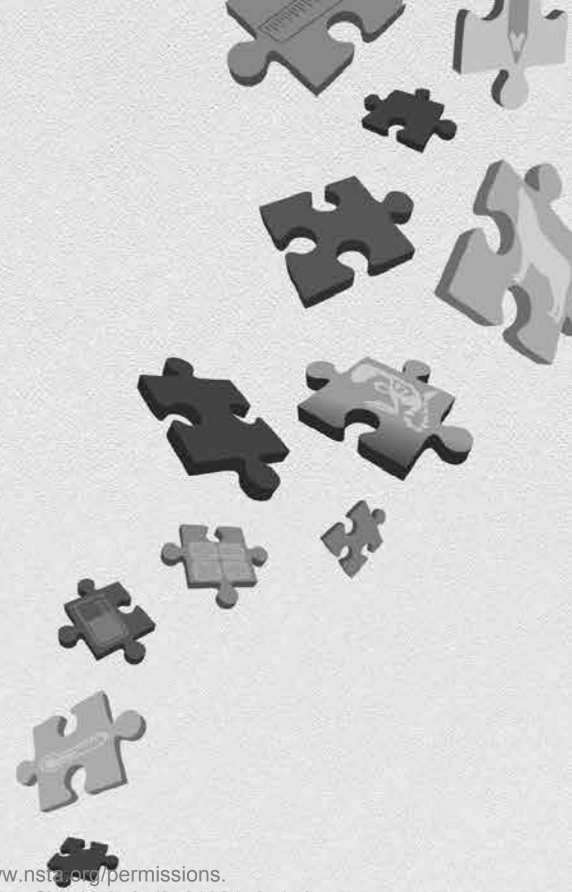

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Arlington, Virginia

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Preface

There are a number of potential reasons for teaching children about science in elementary school. Some people, for example, think it is important to focus on science in the early grades to get students interested in science early so that more people will choose to go into a science or science-related career. Some people think that science is important to teach in the early grades because children ask so many questions about how the world works and the information included as part of the science curriculum is a great way to answer many of their questions. Others think it is important to focus on science in elementary school because children need a strong foundation in the basics so they will be prepared for what they will be expected to know or do in middle or high school. Few people, however, emphasize the importance of teaching science because it is useful for everyday life (Bybee and Pruitt 2017).

Science is useful because it, along with engineering, mathematics, and the technologies that are made possible by these three fields, affects almost every aspect of modern life in one way or another. For example, people need to understand science to be able to think meaningfully about policy issues that affect their communities or to make informed decisions about what food to eat, what medicine to take, or what products to use. People can use their understanding of science to help evaluate the acceptability of different ideas or to convince others about the best course of action to take when faced with a wide range of options. In addition, understanding how science works and all the new scientific findings that are reported each year in the media can be interesting, relevant, and meaningful on a personal level and can open doors to exciting new professional opportunities. The more a person understands science, which includes the theories, models, and laws that scientists have developed over time to explain how and why things happen and how these ideas are developed and refined based on evidence, the easier it is for that person to have a productive and fulfilling life in our technology-based and information-rich society. Science is therefore useful to everyone, not just future scientists.

A Framework for K–12 Science Education (NRC 2012; henceforth referred to as the *Framework*) is based on the idea that all citizens should be able to use scientific ideas to inform both individual choices and collective choices as members of a modern democratic society. It also acknowledges the fact that professional growth and economic opportunity are increasingly tied to the ability to use scientific ideas, processes, and ways of thinking. From the perspective of the *Framework*, it is important for children to learn science because it can help them figure things out or solve problems. It is not enough to remember some facts and terms; people need to be able to use what they have learned while in school. We think that this goal for science education not only is important but also represents a major shift in what should be valued inside the classroom.

The *Framework* asks all of us, as teachers, to reconsider what we teach in grades K–5 and how we teach it, given this goal for science education. It calls for all students, over multiple years of school, to learn how to use disciplinary core ideas (DCIs), crosscutting concepts (CCs), and scientific and engineering practices (SEPs) to figure things out or solve problems. The DCIs are key organizing principles that have broad explanatory power within a discipline. Scientists use these ideas to explain the natural world. The CCs are ideas that are used across disciplines. These concepts provide a framework or a lens that people can use to explore natural phenomena; thus, these concepts often influence what people focus on or pay attention to when they attempt to understand how something works or why something happens. The SEPs are the different activities that scientists engage in as they attempt to generate new concepts, models, theories, or laws that are both valid and reliable. All three of these dimensions of science are important. Students not only need to know about the DCIs, CCs, and SEPs but also must be able to use all three dimensions at the same time to figure things out or to solve problems. These important DCIs, CCs, and SEPs are summarized in Table P-1.

When we give students an opportunity to learn how to use DCIs, CCs, and SEPs to make sense of the world around them, we also provide an authentic context for students to develop fundamental literacy and mathematics skills. Students are able to develop literacy and mathematics skills in this type of context because doing science requires people to obtain, evaluate, and communicate information. Students, for example, must read and talk to others to learn what others have done and what they are thinking. Students must write and speak to share their ideas about what they have learned or what they still need to learn. Students can use mathematics to measure and to discover trends, patterns, or relationships in their observations. They can also use mathematics to make predictions about what will happen in the future. When we give students opportunities to do science, we give students a reason to read, write, speak, and listen. We also create a need for them to use mathematics.

To help students learn how to use DCIs, CCs, and SEPs to figure things out or solve problems while providing them a context to develop fundamental literacy and mathematics skills, elementary teachers will need to use new instructional approaches. These instructional approaches must give students an opportunity to actually do science. To help teachers who teach elementary school make this instructional shift, we have developed a tool called argument-driven inquiry (ADI). ADI is an innovative approach to instruction that gives students an opportunity to use DCIs, CCs, and SEPs to construct and critique claims about how things work or why things happen. As part of this process, students must talk, listen, read, and write to obtain, evaluate, and communicate information. ADI, as a result, creates a rich learning environment for children that enables them to learn science, language, and mathematics at the same time.

TABLE P-1

The three dimensions of *A Framework for K–12 Science Education*

Science and engineering practices (SEPs)	**Crosscutting concepts (CCs)**
• SEP 1: Asking Questions and Defining Problems • SEP 2: Developing and Using Models • SEP 3: Planning and Carrying Out Investigations • SEP 4: Analyzing and Interpreting Data • SEP 5: Using Mathematics and Computational Thinking • SEP 6: Constructing Explanations and Designing Solutions • SEP 7: Engaging in Argument From Evidence • SEP 8: Obtaining, Evaluating, and Communicating Information	• CC 1: Patterns • CC 2: Cause and Effect: Mechanism and Explanation • CC 3: Scale, Proportion, and Quantity • CC 4: Systems and System Models • CC 5: Energy and Matter: Flows, Cycles, and Conservation • CC 6: Structure and Function • CC 7: Stability and Change

Disciplinary core ideas		
Earth and Space Sciences (ESS)	**Life Sciences (LS)**	**Physical Sciences (PS)**
• ESS1: Earth's Place in the Universe • ESS2: Earth's Systems • ESS3: Earth and Human Activity	• LS1: From Molecules to Organisms: Structures and Processes • LS2: Ecosystems: Interactions, Energy, and Dynamics • LS3: Heredity: Inheritance and Variation of Traits • LS4: Biological Evolution: Unity and Diversity	• PS1: Matter and Its Interactions • PS2: Motion and Stability: Forces and Interactions • PS3: Energy • PS4: Waves and Their Applications in Technologies for Information Transfer

Source: Adapted from NRC 2012.

This book describes how ADI works and why it is important, and it provides 14 investigations that can be used in the classroom to help students reach the performance expectations found in the *Next Generation Science Standards* (NGSS Lead States 2013) for third grade.[1] The 14 investigations described in this book will also enable students to develop the disciplinary-based literacy skills outlined in the *Common Core State Standards* for English language arts (NGAC and CCSSO 2010) because ADI

1 See *Argument-Driven Inquiry in Fourth-Grade Science* (Sampson and Murphy, forthcoming) and *Argument-Driven Inquiry in Fifth-Grade Science* (Sampson and Murphy, forthcoming) for additional investigations for students in elementary school.

gives students an opportunity to give presentations to their peers, respond to audience questions and critiques, and then write, evaluate, and revise reports as part of each investigation. In addition, these investigations will help students learn many of the mathematical ideas and practices outlined in the *Common Core State Standards* for mathematics (NGAC and CCSSO 2010) because ADI gives students an opportunity to use mathematics to collect, analyze, and interpret data. Finally, and perhaps most important, ADI can help emerging bilingual students meet the *English Language Proficiency (ELP) Standards* (CCSSO 2014) because it provides a language-rich context where children can use receptive and productive language to communicate and to negotiate meaning with others. Teachers can therefore use these investigations to align how and what they teach with current recommendations for improving science education.

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Ashley Murphy attended Florida State University and earned a BS with dual majors in biology and secondary science education. Ashley taught biology and integrated science at the middle school level before earning a master's degree in STEM education from UT-Austin. While in graduate school at UT-Austin, she taught courses on project-based instruction and elementary science methods. She is an expert in argumentation and three-dimensional instruction in middle and elementary classrooms and science teacher education.

Introduction

A Vision for Science Education in Elementary School

The current aim of science education in the United States is for *all* students to become proficient in science by the time they finish high school. *Science proficiency*, as defined by Duschl, Schweingruber, and Shouse (2007), consists of four interrelated aspects. First, it requires an individual to know important scientific explanations about the natural world, to be able to use these explanations to solve problems, and to be able to understand new explanations when they are introduced to the individual. Second, it requires an individual to be able to generate and evaluate scientific explanations and scientific arguments. Third, it requires an individual to understand the nature of scientific knowledge and how scientific knowledge develops over time. Finally, and perhaps most important, an individual who is proficient in science should be able to participate in scientific practices (such as planning and carrying out investigations, analyzing and interpreting data, and arguing from evidence) and communicate in a manner that is consistent with the norms of the scientific community. These four aspects of science proficiency include the knowledge and skills that all people need to have to be able to pursue a degree in science, be prepared for a science-related career, and participate in a democracy as an informed citizen.

This view of science proficiency serves as the foundation for *A Framework for K–12 Science Education* (the *Framework;* NRC 2012). The *Framework* calls for all students to learn how to use disciplinary core ideas (DCIs), crosscutting concepts (CCs), and scientific and engineering practices (SEPs) to figure things out or solve problems as a way to help them develop the four aspects of science proficiency. The *Framework* was used to guide the development of the *Next Generation Science Standards* (*NGSS;* NGSS Lead States 2013). The goal of the *NGSS*, and other sets of academic standards that are based on the *Framework*, is to describe what *all* students should be able to do at each grade level or at the end of each course as they progress toward the ultimate goal of science proficiency.

The DCIs found in the *Framework* and the *NGSS* are scientific theories, laws, or principles that are central to understanding a variety of natural phenomena. An example of a DCI in Earth and Space Sciences is that the solar system consists of the Sun and a collection of objects that are held in orbit around the Sun by its gravitational pull on them. This DCI not only can be used to help explain the motion of planets around the Sun but also can be used to explain why we have tides on Earth, why the appearance of the Moon changes over time in a predictable pattern, and why we see eclipses of the Sun and the Moon.

The CCs are ideas that are important across the disciplines of science. The CCs help people think about what to focus on or pay attention to during an investigation. For example, one of the CCs from the *Framework* is Energy and Matter: Flows, Cycles, and Conservation. This CC is important in many different fields of study, including astronomy, geology, and meteorology. This CC is equally important in physics and biology. Physicists use this CC when they study how things move, why things change temperature, and the behavior of circuits, magnets, and generators. Biologists use this CC when they study how cells work, the growth and development of plants or animals, and the nature of ecosystems. It is important to highlight the centrality of this idea, and other CCs, for students as we teach the subject-specific DCIs.

The SEPs describe what scientists do as they attempt to make sense of the natural world. Students engage in practices to build, deepen, and apply their knowledge of DCIs and CCs. Some of the SEPs include familiar aspects of what we typically associate with "doing" science, such as Asking Questions and Defining Problems, Planning and Carrying Out Investigations, and Analyzing and Interpreting Data. More important, however, some of the SEPs focus on activities that are related to developing and sharing new ideas, solutions to problems, or answers to questions. These SEPs include Developing and Using Models; Constructing Explanations and Designing Solutions; Engaging in Argument From Evidence; and Obtaining, Evaluating, and Communicating Information. All of these SEPs are important to learn because scientists engage in different practices, at different times, and in different orders depending on what they are studying and what they are trying to accomplish at that point in time.

Few students in elementary school have an opportunity to learn how to use DCIs, CCs, and SEPs to figure things out or to solve problems. Instead, most students are introduced to facts, concepts, and vocabulary without a real reason to know or use them. This type of focus in elementary school does little to promote and support the development of science proficiency because it emphasizes "learning about" science rather than learning how to use science to "figure things out." This type of focus also reflects a view of teaching that defines *rigor* as covering more topics and *learning* as the simple acquisition of more information.

We must think about rigor in different ways before we can start teaching science in ways described by the *Framework*. Instead of using the number of different topics covered in a particular grade level as a way to measure rigor in our schools (e.g., "we made third grade more challenging by adding more topics for students to learn about"), we must start to measure rigor in terms of the number of opportunities students have to use DCIs, CCs, and SEPs to make sense of different phenomena (e.g., "we made third grade more challenging because students have to figure out how to predict the motion of ball once is dropped into a half-pipe"). A rigorous class, in other words, should be viewed as one where students are expected to do science, not just learn about science. From this perspective, our goal as teachers should be to help our students learn how to use DCIs and CCs as tools to plan and carry out investigations, construct and evaluate explanations, and question how we know what we know instead of just ensuring that we "cover" all the different DCIs and CCs that are included in the standards by the end of the school year.

We must also rethink what learning is and how it happens to better promote and support the development of science proficiency. Rather than viewing learning as an individual process where children accumulate more and more information over time, we need to view learning as a social and then an individual process that involves being exposed to new ideas and ways of doing things, trying out these new ideas and practices under the guidance of more experienced people, and then adopting the ideas and practices that are found to be useful for making sense of the world (NRC 1999, 2008, 2012). Learning, from this perspective, requires children to "do science" while in school not because it is fun or interesting (which is true for many) but because doing science gives children a reason to use the ideas and practices of science. When children are given repeated opportunities to use DCIs, CCs, and SEPs as a way to make sense of the world, they will begin to see why these ideas, concepts, and practices are valuable. Over time, children will then adopt these ideas and practices and start using them on their own. We therefore must give our students an opportunity to experience how scientists figure things out and share ideas so they can become "socialized to a greater or lesser extent into the practices of the scientific community with its particular purposes, ways of seeing, and ways of supporting its knowledge claims" (Driver et al. 1994, p. 8).

It is important to keep in mind that helping children learn how to use the ideas and practices of science to figure things out by giving them an opportunity to do science is not a "hands-off" approach to teaching. The process of learning to use the ideas and practices of science to figure things out requires constant input and guidance about "what counts" from teachers who are familiar with the goals of science, the norms of science, and the ways things are done in science. Thus, learning how to use DCIs, CCs, and SEPs to figure things out or to solve problems is dependent on supportive and informative interactions with teachers. This is important because students must have a supportive and educative learning environment to try out new ideas and practices, make mistakes, and refine what they know and how they do things before they are able to adopt the ideas and practices of science as their own.

The Need for New Ways of Teaching Science in Elementary School

Science in elementary school is often taught though a combination of direct instruction and hands-on activities. A typical lesson often begins with the teacher introducing students to a new concept and related terms through direct instruction. Next, the teacher will often show the students a demonstration or give them a hands-on activity to complete to illustrate the concept. The purpose of including a demonstration or a hands-on activity in the lesson is to provide the students with a memorable experience with the concept. If the memorable experience is a hands-on activity, the teacher will often provide his or her students with a step-by-step procedure to follow and a data table to fill out to help ensure that no one in the class "gets lost" or "does the wrong thing" and everyone "gets the right results." The teacher will usually assign a set of questions for the students to answer on their own or in groups after the demonstration or the hands-on activity to make sure that everyone in the class "reaches the right conclusion." The lesson usually ends with the teacher reviewing the concept and all related terms to make sure that everyone in the class learned what they were "supposed to have learned." The teacher often accomplishes this last step of the lesson by leading a whole-class discussion, by assigning a worksheet to complete, or by having the students play an educational game.

Classroom-based research, however, suggests that this type of lesson does little to help students learn key concepts (Duschl, Schweingruber, and Shouse 2007; NRC 2008, 2012). This finding is troubling because, as noted earlier, one of the main goals of this type of lesson is to help students understand an important concept by giving them a memorable experience with it. In addition, this type of lesson does little to help students learn how to plan and carry out investigations or analyze and interpret data because students have no voice or choice during the activity. Students are expected to simply follow a set of directions rather than having to think about what data they will collect, how they will collect it, and what they will need to do to analyze it once they have it. These types of activities can also lead to misunderstanding about the nature of scientific knowledge and how this knowledge is developed over time due to the emphasis on following procedure and getting the right results. These hand-on activities, as a result, do not reflect how science is done at all.

Over the last decade, many elementary school teachers have adopted more inquiry-based approaches to science teaching to address the many shortcomings of these typical science lessons. Inquiry-based lessons that are consistent with the definition of *inquiry* found in *Inquiry and the National Science Education Standards* (NRC 2000) share five key features:

1. Students need to answer a scientifically oriented question.
2. Students must collect data or use data collected by someone else.
3. Students formulate an answer to the question based on their analysis of the data.
4. Students connect their answer to some theory, model, or law.
5. Students communicate their answer to the question to someone else.

Introduction

Teachers often use inquiry-based lessons as a way to give students a firsthand experience with a concept before introducing terms and vocabulary (NRC 2012). Inquiry-based lessons, as a result, are often described as an "activity before content" approach to teaching science (Cavanagh 2007). The focus of these "activity before content" lessons, as the name implies, is to help students understand the core ideas of science. Inquiry-based lessons also give students more opportunities to learn how to plan and carry out investigations, analyze and interpret data, and develop explanations. These lessons also give students more voice and choice so they are more consistent with how science is done.

Although classroom-based research indicates that inquiry-based lessons are effective at helping students understand core ideas and give students more voice and choice than typical science lessons, they do not do as much as they could do to help students develop all four aspects of science proficiency (Duschl, Schweingruber, and Shouse 2007; NRC 2008, 2012). For example, inquiry-based lessons are usually not designed in a way that encourages students to learn how to use DCIs, CCs, and SEPs because they are often used to help student "learn about" important concepts or principles (NRC 2012). These lessons also do not give students an opportunity to participate in the full range of SEPs because these lessons tend to be designed in a way that gives students many opportunities to learn how to ask questions, plan and carry out investigations, and analyze and interpret data but few opportunities to learn how to participate in the practices that focus on how new ideas are developed, shared, refined, and eventually validated within the scientific community. These important sense-making practices include developing and using models; constructing explanations; arguing from evidence; and obtaining, evaluating, and communicating information (NRC 2012). Inquiry-based lessons that do not focus on sense-making also do not provide a context that creates a need for students to read, write, and speak, because these lessons tend to focus on introducing students to new ideas and how to design and carry out investigations instead of how to develop, share, critique, and revise ideas. These types of inquiry-based lessons, as a result, are often not used as a way to help students develop fundamental literacy skills. To help address this problem, teachers will need to start using instructional approaches that give students more opportunities to figure things out.

This emphasis on "figuring things out" instead of "learning about things" represents a big change in the way we have been teaching science in elementary school. To figure out how things work or why things happen in a way that is consistent with how science is actually done, students must have opportunities to use DCIs, CCs, and SEPs at the same time to make sense of the world around them (NRC 2012). This focus on students using DCIs, CCs, and SEPs at the same time during a lesson is called *three-dimensional instruction* because students have an opportunity to use all three dimensions of the *Framework* to understand how something works, to explain why something happens, or to develop a novel solution to a problem. When teachers use three-dimensional instruction inside their classrooms, they encourage students to develop or use conceptual models, develop explanations, share and critique ideas, and argue from evidence, all of which allow students to develop the knowledge and skills they need to be proficient in science (NRC 2012). A large body of research suggests that all students benefit from three-dimensional instruction because it gives all students more voice and choice during a lesson and it makes the learning process inside the classroom more active and inclusive (NRC 2012).

We think investigations that focus on making sense of how the world works are the perfect way to integrate three-dimensional science instruction into elementary classrooms. Well-designed investigations can provide opportunities for students to not only use one or more DCIs to understand how something works, to explain why something happens, or to develop a novel solution to a problem but also use several different CCs and SEPs during the same lesson. A teacher, for example, can give his or her students an opportunity to figure out a way to predict the motion of a ball over time when it dropped into a half-pipe. The teacher can then encourage them to use what they know about Forces and Motion (a DCI) and their understanding of Patterns (a CC) to plan and carry out an investigation to figure out where the ball will be in the half-pipe each time it changes direction. In addition to planning and carrying out an investigation, they must also ask questions; analyze and interpret data; use mathematics; construct an explanation; argue from evidence; and obtain, evaluate, and communicate information (seven different SEPs).

Using a DCI along with multiple CCs and SEPs at the same time is important because it creates a classroom experience that parallels how science is done. This, in turn, gives all students who participate in the investigation an opportunity to deepen their understanding of what it means to do science and to develop science-related identities (Carlone, Scott, and Lowder 2014; Tan and Barton 2008, 2010). In the following section, we will describe how to promote and support the development of science proficiency through three-dimensional instruction by using an innovative instructional model called argument-driven inquiry (ADI).

Argument-Driven Inquiry as a Way to Promote Three-Dimensional Instruction While Focusing on Literacy and Mathematics

The ADI instructional model (Sampson and Gleim 2009; Sampson, Grooms, and Walker 2009, 2011) was developed as a way to change how science is taught in our schools. Rather than simply encouraging students to learn about the facts, concepts, and terms of science, ADI gives students an opportunity to use DCIs, CCs, and SEPs to figure out how things work or why things happen. ADI also encourages children to think about "how we know" in addition to "what we have figured out." The ADI instructional model includes eight stages of classroom activity. These eight stages give children an opportunity to *investigate* a phenomenon; *make sense* of that phenomenon; and *evaluate and refine* ideas, explanations, or arguments. These three aspects of doing science help students learn how to figure something out and make it possible for them to develop and refine their understanding of the DCIs, CCs, and SEPs over time.

Students will use different SEPs depending on what they are trying to accomplish during an investigation, which changes as they move through the eight stages of ADI. For example, students must learn how to ask questions to design and carry out an investigation in order to investigate a phenomenon, which is the overall goal of the first two stages of ADI. Then during the next stage of ADI, the students must learn how to analyze and interpret data, use mathematics, develop models, and construct explanations to accomplish the goal of making sense of the phenomenon they are studying. Students then need to evaluate and refine ideas, explanations, or arguments during the last five stages of this instructional model. Students, as a result, must learn how to ask questions; obtain, evaluate, and communicate information; and argue from evidence. These three goals therefore provide coherence to a three-dimensional lesson, create a need for students to learn how to use each of the SEPs (along with DCIs and CCs), and will keep the focus of the lesson on figuring things out. We will discuss what students do during each stage of ADI in greater detail in Chapter 1.

ADI also provides an authentic context for students to develop fundamental literacy and mathematics skills. Students are able to develop these skills during an ADI investigation because the use of DCIs, CCs, and SEPs requires them to gather, analyze, interpret, and communicate information. Students, for example, must read and talk to others to learn to gather information and to find out how others are thinking. Students must also talk and write to share their ideas about what they are doing and what they have found out and to revise an explanation or model. Students, as a result, "are able to fine-tune their literacy skills when they engage in science investigations because so many of the sense-making tools of science are consistent with, if not identical to, those of literacy, thus allowing a setting for additional practice and refinement that can enhance future reading and writing efforts" (Pearson, Moje, and Greenleaf 2010, p. 460). Students must also use mathematics during an ADI investigation to measure what they are studying and to find patterns in their observations, uncover differences between groups, identify a trend over time, or confirm a relationship between two variables. They also use mathematics to make predictions. Teachers can therefore use ADI to help students develop important literacy and mathematics skills as they teach science. We will discuss how to promote and support the development of literacy and mathematics skills during the various stages of ADI with greater detail in Chapter 1. We will also describe ways to promote and support productive talk, reading, and writing during ADI in the Teacher Notes for each investigation.

ADI investigations also provide a rich language-learning environment for emerging bilingual students who are learning how to communicate in English. A rich language-learning environment is important because emerging bilingual students must (1) interact with people who know English well enough to provide both access to this language and help in learning it and (2) be in a social setting that will bring them in contact with these individuals so they have an opportunity to learn (Lee, Quinn, and Valdés 2013). Once these two conditions are met, people are able to learn a new language through meaningful use and interaction (Brown 2007; García 2005; García and Hamayan 2006; Kramsch 1998). ADI, and its focus on giving students opportunities to use DCIs, CCs, and SEPs to figure things out, also provides emerging bilingual students with opportunities to interact with English speakers and opportunities to do things with language inside the classroom (Lee, Quinn, and Valdés 2013). Emerging bilingual students therefore have an opportunity to use receptive and productive language to communicate and to negotiate meaning with others inside the science classroom. Teachers, as a result, can promote and support the acquisition of a new language by simply using ADI to give emerging bilingual students an opportunity to *investigate* a phenomenon; *make sense* of that phenomenon; and *evaluate and refine* ideas, explanations, or arguments with others and then provide support and guidance as they learn how to communicate in a new language. We will discuss how teachers can use ADI to promote language development with greater detail in Chapter 1. We will also provide advice and recommendations for supporting emerging bilingual students as they learn science and how to communicate in a new language at the same time in the Teacher Notes for each investigation.

Organization of This Book

This book is divided into seven sections. Section 1 includes two chapters. The first chapter describes the ADI instructional model. The second chapter provides an overview of the information that is associated with each investigation. Sections 2–6 contain the 14 investigations. Each investigation includes three components:

- Teacher Notes, which provides information about the purpose of the investigation and what teachers need to do to guide students through it.
- Investigation Handout, which can be photocopied and given to students at the beginning of the lesson. The handout provides the students with

a phenomenon to investigate, an overview of the DCI and the CC that students can use during the investigation, and a guiding question to answer.

- Checkout Questions, which can be photocopied and given to students at the conclusion of the investigation. The Checkout Questions consist of items that target students' understanding of the DCI and the CC addressed during the investigation.

Section 7 consists of five appendixes:

- Appendix 1 contains several standards alignment matrixes that can be used to assist with curriculum or lesson planning.
- Appendix 2 provides an overview of the CCs and nature of scientific knowledge (NOSK) and nature of scientific inquiry (NOSI) concepts that are a focus of the different investigations. This information about the CCs and the NOSK and NOSI concepts are included as a reference for teachers.
- Appendix 3 lists some frequently asked questions about ADI.
- Appendix 4 provides of a peer-review guide and teacher scoring rubric, which can also be photocopied and given to students.
- Appendix 5 provides a safety acknowledgment form, which can be photocopied and given to students.

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Investigation 6

Life in Groups: Why Do Wolves Live in Groups?

Purpose

The purpose of this investigation is to give students an opportunity to use the disciplinary core idea (DCI) of LS2.D: Social Interactions and Group Behavior and the crosscutting concept (CC) of Cause and Effect from *A Framework for K–12 Science Education* (NRC 2012) to figure out why wolves live in groups. Students will also learn about how scientists use different methods to answer different types of questions during the reflective discussion.

The Disciplinary Core Idea

Students in third grade should understand the following about Social Interactions and Group Behavior and be able to use this DCI to figure out if living in a group makes it easier for wolves to get the food they need to survive:

> *Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. (NRC 2012, p. 156)*

The Crosscutting Concept

Students in third grade should understand the following about the CC Cause and Effect:

> *Repeating patterns in nature, or events that occur together with regularity, are clues that scientists can use to start exploring causal, or cause-and-effect, relationships. … Any application of science, or any engineered solution to a problem, is dependent on understanding the cause-and-effect relationships between events; the quality of the application or solution often can be improved as knowledge of the relevant relationships is improved. (NRC 2012, p. 87)*

Students in third grade should be given opportunities to begin to "look for and analyze patterns—whether in their observations of the world or in the relationships between different quantities in data (e.g., the sizes of plants over time)"; "they can also begin to consider what might be causing these patterns and relationships and design tests that gather more evidence to support or refute their ideas" (NRC 2012, pp. 88–89).

Students should be encouraged to use their developing understanding of cause-and-effect relationships as a tool or a way of thinking about a phenomenon during this investigation to help them figure out if living in a group (the cause) makes it easier for wolves to get the food they need to survive (the effect).

What Students Figure Out

Groups of wolves (called packs) are able to hunt larger prey than wolves hunting on their own. Wolves also tend to be more successful (in catching and killing an animal) when they hunt as part of a pack. Wolf packs are hierarchies with dominant members, consist of both male and females, and tend to be stable over time.

Timeline

The time needed to complete this investigation is 280 minutes (4 hours and 40 minutes). The amount of instructional time needed for each stage of the investigation is as follows:

- *Stage 1.* Introduce the task and the guiding question: 35 minutes
- *Stage 2.* Design a method and collect data: 70 minutes
- *Stage 3.* Create a draft argument: 35 minutes
- *Stage 4.* Argumentation session: 30 minutes
- *Stage 5.* Reflective discussion: 15 minutes
- *Stage 6.* Write a draft report: 35 minutes
- *Stage 7.* Peer review: 30 minutes
- *Stage 8.* Revise the report: 30 minutes

This investigation can be completed in one day or over eight days (one day for each stage) during your designated science time in the daily schedule.

Materials and Preparation

The materials needed for this investigation are listed in Table 6.1 (p. 220). In addition to these materials, students will need to watch several videos of wolves hunting different prey. These videos, which are available online, are listed below together with the URLs for accessing them; this list is also included in the Investigation 6 supplementary materials on the book's Extras page at *www.nsta.org/adi-3rd*, and any changes that occur in the video titles and/or URLs will be made on the Extras page.

Video watched in stage 1:

- "Musk Ox vs. Wolves / National Geographic": *www.youtube.com/watch?v=pb6Rke7jiTc*

Videos watched in stage 2:

- "Wolves Hunting Caribou—Planet Earth—BBC Wildlife" (1 wolf): *https://youtu.be/A0E6geAq1k8*
- "Wolf Hunting Elk in Yellowstone / BBC" (4 wolves): *https://youtu.be/bfGP4Xbme3o*
- "Wolf Hunts Caribou—Nature's Epic Journeys: Episode 2 Preview" (1 wolf): *www.youtube.com/watch?v=NdVIxS8tgYM*

- "Pack of Wolves Hunt a Bison / Frozen Planet / BBC Earth" (25 wolves): *www.youtube.com/watch?v=8wl8ZxAaB2E*
- "Baby Bison Takes on Wolf and Wins / American's National Parks" (1 wolf): *https://youtu.be/K6TnWW1s4hE*
- "Nature / Wolves Hunting Buffalo / Cold Warriors: Wolves and Buffalo / PBS" (3 wolves): *https://youtu.be/tCG1I-Ssgww*
- "Clash: Encounters of Bears and Wolves / Clip 2 / PBS" (several wolves): *www.youtube.com/watch?v=ZNrEOZ4xCGY*
- "Bison and Her Calf Battle Wolves / North America" (3 wolves): *www.youtube.com/watch?v=GtG-9ftqoHw*

Students will need a computer or tablet that can access the internet and YouTube to view these videos. We recommend at least one computer or tablet per group, but each student can use a computer or tablet on his or her own if there are enough available. We also recommend making photocopies of the list of videos (you can use the list in the supplementary materials), bookmarking the URLs on the class computers or tablets, or creating a Google document with hyperlinks to the videos that you can share with the students to make it easier for the students to find and access the videos during the investigation. Some schools restrict web browsing, so be sure to check to see if students can access each video from a school computer before you begin the investigation.

TABLE 6.1

Materials for Investigation 6

Item	Quantity
Computer or tablet that can access the internet and YouTube	1 per group
Whiteboard, 2' × 3'*	1 per group
Investigation Handout	1 per student
Peer-review guide and teacher scoring rubric	1 per student
Checkout Questions (optional)	1 per student

* As an alternative, students can use computer and presentation software such as Microsoft PowerPoint or Apple Keynote to create their arguments.

Safety Precautions

Remind students to follow all normal safety rules.

Lesson Plan by Stage

Stage 1: Introduce the Task and the Guiding Question (35 minutes)

1. Ask the students to sit in six groups, with three or four students in each group.
2. Ask students to clear off their desks except for a pencil (and their *Student Workbook for Argument-Driven Inquiry in Third-Grade Science* if they have one).
3. Pass out an Investigation Handout to each student (or ask students to turn to Investigation Log 6 in their workbook).
4. Read the first paragraph of the "Introduction" aloud to the class. Ask the students to follow along as you read.
5. Show the video "Musk Ox vs. Wolves / National Geographic" (available at *www.youtube.com/watch?v=pb6Rke7jiTc).*
6. Tell students to record their observations and questions about the video in the "OBSERVED/WONDER" chart in the "Introduction" section of their Investigation Handout (or the investigation log in their workbook).
7. Ask students to share *what they observed* as they watched the video.
8. Ask students to share *what questions they have* about what they observed as they watched the video.
9. Tell the students, "Some of your questions might be answered by reading the rest of the 'Introduction.'"
10. Ask the students to read the rest of the "Introduction" on their own *or* ask them to follow along as you read aloud.
11. Once the students have read the rest of the "Introduction," ask them to fill out the "KNOW/NEED" chart on their Investigation Handout (or in their investigation log) as a group.
12. Ask students to share what they learned from the reading. Add these ideas to a class "know / need to figure out" chart.
13. Ask students to share what they think they will need to figure out based on what they read. Add these ideas to the class "know / need to figure out" chart.
14. Tell the students, "It looks like we have something to figure out. Let's see what we will need to do during our investigation."
15. Read the task and the guiding question aloud.
16. Tell the students, "I have lots of videos that you can use."
17. Introduce the students to the videos available for them to use during the investigation by showing them how to access them on the computers or tablets.

Stage 2: Design a Method and Collect Data (70 minutes)

1. Tell the students, "I am now going to give you and the other members of your group about 15 minutes to plan your investigation. Before you begin, I want you all to take a couple of minutes to discuss the following questions with the rest of your group."
2. Show the following questions on the screen or board:
   - What types of *patterns* might we look for to help answer the guiding question?
   - What information do we need to find a *cause-and-effect relationship?*
3. Tell the students, "Please take a few minutes to come up with an answer to these questions." Give the students two or three minutes to discuss these two questions.
4. Ask two or three different groups to share their answers. Be sure to highlight or write down any important ideas on the board so students can refer to them later.
5. If possible, use a document camera to project an image of the graphic organizer for this investigation on a screen or board (or take a picture of it and project the picture on a screen or board). Tell the students, "I now want you all to plan out your investigation. To do that, you will need to create an investigation proposal by filling out this graphic organizer."
6. Point to the box labeled "Our guiding question:" and tell the students, "You can put the question we are trying to answer in this box." Then ask, "Where can we find the guiding question?"
7. Wait for a student to answer where to find the guiding question (the answer is "in the handout").
8. Point to the box labeled "We will collect the following data from the videos:" and tell the students, "You can list the observations that you will need to collect during the investigation in this box."
9. Point to the box labeled "These are the steps we will follow to collect data as we watch the videos:" and tell the students, "You can list what you are going to do to collect the data you need and what you will do with your data once you have it. Be sure to give enough detail that I could do your investigation for you."
10. Ask the students, "Do you have any questions about what you need to do?"
11. Answer any questions that come up.
12. Tell the students, "Once you are done, raise your hand and let me know. I'll then come by and look over your proposal and give you some feedback. You may not begin collecting data until I have approved your proposal by signing it. You need to have your proposal done in the next 15 minutes."

13. Give the students 15 minutes to work in their groups on their investigation proposal. As they work, move from group to group to check in, ask probing questions, and offer a suggestion if a group gets stuck.

What should a student-designed investigation look like?

The students' investigation proposal should include the following information:

- The guiding question is "Why do wolves live in groups?"
- The data that the student should collect are (1) number of wolves, (2) type of prey, and (3) if the hunt was successful or not.
- To collect the data, the students could follow these steps (but this is just an example, and there should be a lot of variation in the student-designed investigation):
  1. Watch a video of a wolf hunt.
  2. Make observations about the number of wolves hunting, what the wolves are hunting, and if they catch what they are hunting or not.
  3. Repeat steps 1 and 2 for each video.
  4. Determine if living in a group (the cause) makes it easier for wolves to get the food they need to survive (the effect).

14. As each group finishes its investigation proposal, be sure to read it over and determine if it will be productive or not. If you feel the investigation will be productive (not necessarily what you would do or what the other groups are doing), sign your name on the proposal and let the group start collecting data. If the plan needs to be changed, offer some suggestions or ask some probing questions, and have the group make the changes before you approve it.
15. Give the students about 30 minutes to watch the videos and collect their data.
16. Be sure to remind the students to collect their data and record their observations or measurements in the "Collect Your Data" box in their Investigation Handout (or the investigation log in their workbook).

Stage 3: Create a Draft Argument (35 minutes)

1. Tell the students, "Now that we have all this data, we need to analyze the data so we can figure out an answer to the guiding question."
2. If possible, project an image of the "Analyze Your Data" text and box for this investigation on a screen or board using a document camera (or take a picture

of it and project the picture on a screen or board). Point to the box and tell the students, "You can create a table or a graph as a way to analyze your data. You can make your table or graph in this box."

3. Ask the students, "What information do we need to include in a table or graph?"
4. Tell the students, "Please take a few minutes to discuss this question with your group, and be ready to share."
5. Give the students five minutes to discuss.
6. Ask two or three different groups to share their answers. Be sure to highlight or write down any important ideas on the board so students can refer to them later.
7. Tell the students, "I am now going to give you and the other members of your group about 10 minutes to create a table or graph." If the students are having trouble making a table or graph, you can take a few minutes to provide a mini-lesson about how to create a table or graph from a bunch of observations or measurements (this strategy is called just-in-time instruction because it is offered only when students get stuck).

What should a table or graph look like for this investigation?

There are a number of different ways that students can analyze the observations they collect during this investigation. One of the most straightforward ways is to create a table with three columns. The first column can be labeled "number of wolves," the second column can be labeled "type of prey," and the third column can be labeled "hunt successful or not." The students can then include the appropriate observations from each video in each row (e.g., the first row would include data from the first video they watched, the second row would include data from the second video they watched, and so on). This allows them to show a clear pattern as part of their analysis of the data. An example of this type of table can be seen in Figure 6.1 (p. 226). There are other many possible ways to analyze the data for this investigation. Students often come up with some unique ways of analyzing their data, so be sure to give them some voice and choice during this stage.

8. Give the students 10 minutes to analyze their data. As they work, move from group to group to check in, ask probing questions, and offer suggestions.
9. Tell the students, "I am now going to give you and the other members of your group 15 minutes to create an argument to share what you have learned and

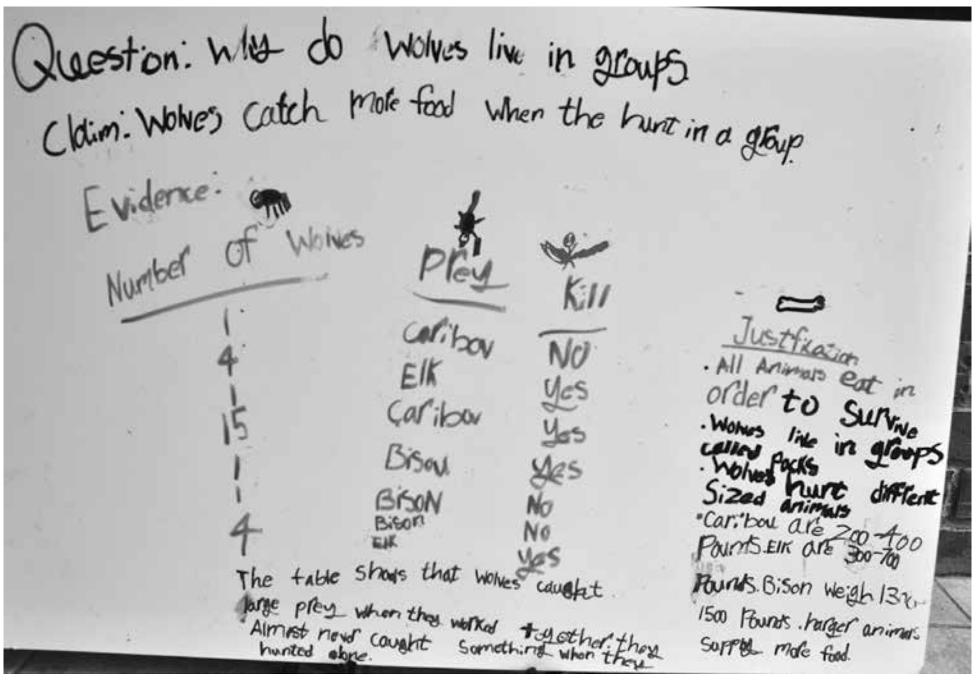
convince others that they should believe you. Before you do that, we need to take a few minutes to discuss what you need to include in your argument."

10. If possible, use a document camera to project the "Argument Presentation on a Whiteboard" image from the Investigation Handout (or the investigation log in their workbook) on a screen or board (or take a picture of it and project the picture on a screen or board).
11. Point to the box labeled "The Guiding Question:" and tell the students, "You can put the question we are trying to answer here on your whiteboard."
12. Point to the box labeled "Our Claim:" and tell the students, "You can put your claim here on your whiteboard. The claim is your answer to the guiding question."
13. Point to the box labeled "Our Evidence:" and tell the students, "You can put the evidence that you are using to support your claim here on your whiteboard. Your evidence will need to include the analysis you just did and an explanation of what your analysis means or shows. Scientists always need to support their claims with evidence."
14. Point to the box labeled "Our Justification of the Evidence:" and tell the students, "You can put your justification of your evidence here on your whiteboard. Your justification needs to explain why your evidence is important. Scientists often use core ideas to explain why the evidence they are using matters. Core ideas are important concepts that scientists use to help them make sense of what happens during an investigation."
15. Ask the students, "What are some core ideas that we read about earlier that might help us explain why the evidence we are using is important?"
16. Ask students to share some of the core ideas from the "Introduction" section of the Investigation Handout (or the investigation log in the workbook). List these core ideas on the board.
17. Tell the students, "That is great. I would like to see everyone try to include these core ideas in your justification of the evidence. Your goal is to use these core ideas to help explain why your evidence matters and why the rest of us should pay attention to it."
18. Ask the students, "Do you have any questions about what you need to do?"
19. Answer any questions that come up.
20. Tell the students, "Okay, go ahead and start working on your arguments. You need to have your argument done in the next 15 minutes. It doesn't need to be perfect. We just need something down on the whiteboards so we can share our ideas."
21. Give the students 15 minutes to work in their groups on their arguments. As they work, move from group to group to check in, ask probing questions, and

offer a suggestion if a group gets stuck. Figure 6.1 shows an example of an argument created by students for this investigation.

FIGURE 6.1

Example of an argument



Stage 4: Argumentation Session (30 minutes)

The argumentation session can be conducted in a whole-class presentation format, a gallery walk format, or a modified gallery walk format. We recommend using a whole-class presentation format for the first investigation, but try to transition to either the gallery walk or modified gallery walk format as soon as possible because that will maximize student voice and choice inside the classroom. The following list shows the steps for the three formats; unless otherwise noted, the steps are the same for all three formats.

1. Begin by introducing the use of the whiteboard.
   - *If using the whole-class presentation format,* tell the students, "We are now going to share our arguments. Please set up your whiteboard so everyone can see them."
   - *If using the gallery walk or modified gallery walk format,* tell the students, "We are now going to share our arguments. Please set up your whiteboard so they are facing the walls."
2. Allow the students to set up their whiteboards.

- *If using the whole-class presentation format,* the whiteboards should be set up on stands or chairs so they are facing toward the center of the room.
- *If using the gallery walk or modified gallery walk format,* the whiteboards should be set up on stands or chairs so they are facing toward the outside of the room.

3. Give the following instructions to the students:
    - *If using the whole-class presentation format or the modified gallery walk format*, tell the students, "Okay, before we get started I want to explain what we are going to do next. I'm going to ask some of you to present your arguments to your classmates. If you are presenting your argument, your job is to share your group's claim, evidence, and justification of the evidence. The rest of you will be reviewers. If you are a reviewer, your job is to listen to the presenters, ask the presenters questions if you do not understand something, and then offer them some suggestions about ways to make their argument better. After we have a chance to learn from each other, I'm going to give you some time to revise your arguments and make them better."
    - *If using the gallery walk format*, tell the students, "Okay, before we get started I want to explain what we are going to do next. You are going to have an opportunity to read the arguments that were created by other groups. Your group will go to a different group's argument. I'll give you a few minutes to read it and review it. Your job is to offer them some suggestions about ways to make their argument better. You can use sticky notes to give them suggestions. Please be specific about what you want to change and be specific about how you think they should change it. After we have a chance to learn from each other, I'm going to give you some time to revise your arguments and make them better."
4. Use a document camera to project the "Ways to IMPROVE our argument …" box from the Investigation Handout (or the investigation log in their workbook) on a screen or board (or take a picture of it and project the picture on a screen or board).
    - *If using the whole-class presentation format or the modified gallery walk format,* point to the box and tell the students, "If you are a presenter, you can write down the suggestions you get from the reviewers here. If you are a reviewer, and you see a good idea from another group, you can write down that idea here. Once we are done with the presentations, I will give you a chance to use these suggestions or ideas to improve your arguments.
    - *If using the gallery walk format*, point to the box and tell the students, "If you see good ideas from another group, you can write them down here. Once we are done reviewing the different arguments, I will give you a chance to use these ideas to improve your own arguments. It is important to share ideas like this."

    Ask the students, "Do you have any questions about what you need to do?"

5. Answer any questions that come up.
6. Give the following instructions:
    - *If using the whole-class presentation format,* tell the students, "Okay. Let's get started."
    - *If using the gallery walk format,* tell the students, "Okay, I'm now going to tell you which argument to go to and review.
    - *If using the modified gallery walk format,* tell the students, "Okay, I'm now going to assign you to be a presenter or a reviewer." Assign one or two students from each group to be presenters and one or two students from each group to be reviewers.
7. Begin the review of the arguments.
    - *If using the whole-class presentation format,* have four or five groups present their argument one at a time. Give each group only two to three minutes to present their argument. Then give the class two to three minutes to ask them questions and offer suggestions. Be sure to encourage as much participation from the students as possible.
    - *If using the gallery walk format,* tell the students, "Okay. Let's get started. Each group, move one argument to the left. Don't move to the next argument until I tell you to move. Once you get there, read the argument and then offer suggestions about how to make it better. I will put some sticky notes next to each argument. You can use the sticky notes to leave your suggestions." Give each group about three to four minutes to read the arguments, talk, and offer suggestions.

        a. Tell the students, "Okay. Let's rotate. Move one group to the left."
        b. Again, give each group three or four minutes to read, talk, and offer suggestions.
        c. Repeat this process for two more rotations.
    - *If using the modified gallery walk format,* tell the students, "Okay. Let's get started. Reviewers, move one group to the left. Don't move to the next group until I tell you to move. Presenters, go ahead and share your argument with the reviewers when they get there." Give each group of presenters and reviewers about three to four minutes to talk.

        a. Tell the students, "Okay. Let's rotate. Reviewers, move one group to the left."
        b. Again, give each group of presenters and reviewers about three or four minutes to talk.
        c. Repeat this process for two more rotations.
8. Tell the students to return to their workstations.
9. Give the following instructions about revising the argument:

- *If using the whole-class presentation format,* tell the students, "I'm now going to give you about 10 minutes to revise your argument. Take a few minutes to talk in your groups and determine what you want to change to make your argument better. Once you have decided what to change, go ahead and make the changes to your whiteboard."
- *If using the gallery walk format,* tell the students, "I'm now going to give you about 10 minutes to revise your argument. Take a few minutes to read the suggestions that were left at your argument. Then talk in your groups and determine what you want to change to make your argument better. Once you have decided what to change, go ahead and make the changes to your whiteboard."
- *If using the modified gallery walk format,* "I'm now going to give you about 10 minutes to revise your argument. Please return to your original groups." Wait for the students to move back into their original groups and then tell the students, "Okay, take a few minutes to talk in your groups and determine what you want to change to make your argument better. Once you have decided what to change, go ahead and make the changes to your whiteboard."

Ask the students, "Do you have any questions about what you need to do?"

10. Answer any questions that come up.
11. Tell the students, "Okay. Let's get started."
12. Give the students 10 minutes to work in their groups on their arguments. As they work, move from group to group to check in, ask probing questions, and offer a suggestion if a group gets stuck.

Stage 5: Reflective Discussion (15 minutes)

1. Tell the students, "We are now going to take a minute to talk about what we did and what we have learned."
2. Show Figure 6.2 on a screen. Ask the students, "What do you all see going on here?"
3. Allow students to share their ideas.

FIGURE 6.2

Wolves hunting an elk

4. Ask the students, "Why would it be beneficial for the wolves to hunt together?"
5. Allow students to share their ideas. Keep probing until someone mentions that they are able to catch larger prey or catch food more often.
6. Ask the students, "What would be some drawbacks of hunting together?"
7. Allow students to share their ideas. Keep probing until someone mentions that they have to split the food.
8. Ask the students, "What are some other benefits of living in a group like this?"
9. Allow students to share their ideas.
10. Tell the students, "Okay, let's make sure we are on the same page. Being part of a group helps animals obtain food, defend themselves, and cope with changes. Wolves, for example, tend to be more successful at catching food when they hunt as part of a pack. Groups may serve different functions and vary dramatically in size. Wolf packs, for example, tend to include 5 to 10 members and include both males and females. These packs have a wolf that is the leader of the pack and wolves that follow the leader, and these relationships tend to be stable over time. The fact that living things often live in groups as a way to help them survive is a really important core idea in science."
11. Ask the students, "Does anyone have any questions about this core idea?"
12. Answer any questions that come up.
13. Tell the students, "We also looked for a cause-and-effect relationship during our investigation." Then ask, "Can anyone tell me why it is useful to look for cause-and-effect relationships?"
14. Allow students to share their ideas.
15. Tell the students, "Cause-and-effect relationships are important because they allow us to predict what will happen in the future."
16. Ask the students, "What was the cause and what was the effect that we uncovered today?"
17. Allow students to share their ideas. Keep probing until someone mentions that the cause was living in a group and the effect was ability to obtain food.
18. Tell the students, "That is great, and if we know that you can predict what will happen the next time we see a wolf pack hunting prey on a video."
19. Tell the students, "We are now going take a minute to talk about what went well and what didn't go so well during our investigation. We need to talk about this because you are going to be planning and carrying out your own investigations like this a lot this year, and I want to help you all get better at it."
20. Show an image of the question "What made your investigation scientific?" on the screen. Tell the students, "Take a few minutes to talk about how you would answer this question with the other people in your group. Be ready to share

with the rest of the class." Give the students two to three minutes to talk in their group.

21. Ask the students, "What do you all think? Who would like to share an idea?"
22. Allow three or four students to share their ideas. Be sure to expand on their ideas about what makes an investigation scientific.
23. Show an image of the question "What made your investigation not so scientific?" on the screen. Tell the students, "Take a few minutes to talk about how you would answer this question with the other people in your group. Be ready to share with the rest of the class." Give the students two to three minutes to talk in their group.
24. Ask the students, "What do you all think? Who would like to share an idea?"
25. Allow students to share their ideas. Be sure to expand on their ideas about what makes an investigation less scientific.
26. Show an image of the question "What rules can we put into place to help us make sure our next investigation is more scientific?" on the screen. Tell the students, "Take a few minutes to talk about how you would answer this question with the other people in your group. Be ready to share with the rest of the class." Give the students two to three minutes to talk in their group.
27. Ask the students, "What do you all think? Who would like to share an idea?"
28. Allow students to share their ideas. Once they have shared their ideas, offer a suggestion for a possible class rule.
29. Ask the students, "What do you all think? Should we make this a rule?"
30. If the students agree, write the rule on the board or make a class "Rules for Scientific Investigation" chart so you can refer to it during the next investigation.
31. Tell the students, "We are now going take a minute to talk about what scientists do to investigate the natural world."
32. Show an image of the question "Do all scientists follow the same method?" on the screen. Tell the students, "Take a few minutes to talk about how you would answer this question with the other people in your group. Be ready to share with the rest of the class." Give the students two to three minutes to talk in their group.
33. Ask the students, "What do you all think? Who would like to share an idea?"
34. Allow students to share their ideas.
35. Tell the students, "Okay, let's make sure we are all on the same page. Scientists use lots of different methods to answer different types of questions. Sometimes they need to go out into the field and watch what animals do. The videos you watched came from scientists working out in the field. Some scientists design experiments, and others analyze data collected by other scientists. There is no

one method that all scientists use, and the method used by scientists depends on what they are studying and what type of question they are asking. This is an important thing to understand about science."

36. Ask the students, "Does anyone have any questions about what scientists do to investigate the natural world?"
37. Answer any questions that come up.

Stage 6: Write a Draft Report (35 minutes)

Your students will use either the Investigation Handout or the investigation log in the student workbook when writing the draft report. When you give the directions shown in quotes in the following steps, substitute "investigation log" (as shown in brackets) for "handout" if they are using the workbook.

1. Tell the students, "You are now going to write an investigation report to share what you have learned. Please take out a pencil and turn to the 'Draft Report' section of your handout [investigation log]."
2. If possible, use a document camera to project the "Introduction" section of the draft report from the Investigation Handout (or the investigation log in their workbook) on a screen or board (or take a picture of it and project the picture on a screen or board).
3. Tell the students, "The first part of the report is called the 'Introduction.' In this section of the report you want to explain to the reader what you were investigating, why you were investigating it, and what question you were trying to answer. All of this information can be found in the text at the beginning of your handout [investigation log]." Point to the image and say, "There are some sentence starters here to help you begin writing the report." Ask the students, "Do you have any questions about what you need to do?"
4. Answer any questions that come up.
5. Tell the students, "Okay. Let's write."
6. Give the students 10 minutes to write the "Introduction" section of the report. As they work, move from student to student to check in, ask probing questions, and offer a suggestion if a student gets stuck.
7. If possible, use a document camera to project the "Method" section of the draft report from the Investigation Handout (or the investigation log in their workbook) on a screen or board (or take a picture of it and project the picture on a screen or board).
8. Tell the students, "The second part of the report is called the 'Method.' In this section of the report you want to explain to the reader what you did during the investigation, what data you collected and why, and how you went about analyzing your data. All of this information can be found in the 'Plan Your

Investigation' section of your handout [investigation log]. Remember that you all planned and carried out different investigations, so do not assume that the reader will know what you did." Point to the image and say, "There are some sentence starters here to help you begin writing this part of the report." Ask the students, "Do you have any questions about what you need to do?"

9. Answer any questions that come up.
10. Tell the students, "Okay. Let's write."
11. Give the students 10 minutes to write the "Method" section of the report. As they work, move from student to student to check in, ask probing questions, and offer a suggestion if a student gets stuck.
12. If possible, use a document camera to project the "Argument" section of the draft report from the Investigation Handout (or the investigation log in their workbook) on a screen or board (or take a picture of it and project the picture on a screen or board).
13. Tell the students, "The last part of the report is called the 'Argument.' In this section of the report you want to share your claim, evidence, and justification of the evidence with the reader. All of this information can be found on your whiteboard." Point to the image and say, "There are some sentence starters here to help you begin writing this part of the report." Ask the students, "Do you have any questions about what you need to do?"
14. Answer any questions that come up.
15. Tell the students, "Okay. Let's write."
16. Give the students 10 minutes to write the "Argument" section of the report. As they work, move from student to student to check in, ask probing questions, and offer a suggestion if a student gets stuck.

Stage 7: Peer Review (30 minutes)

Your students will use either the Investigation Handout or the investigation log in the student workbook when doing the peer review. When you give the directions shown in quotes in the following steps, substitute "workbook" (as shown in brackets) for "Investigation Handout" if they are using the workbook.

1. Tell the students, "We are now going to review our reports to find ways to make them better. I'm going to come around and collect your Investigation Handout [workbook]. While I do that, please take out a pencil."
2. Collect the Investigation Handouts or workbooks from the students.
3. If possible, use a document camera to project the peer-review guide (PRG; see Appendix 4) on a screen or board (or take a picture of it and project the picture on a screen or board).

4. Tell the students, "We are going to use this peer-review guide to give each other feedback." Point to the image.
5. Give the following instructions:
   - *If using the Investigation Handout,* tell the students, "I'm going to ask you to work with a partner to do this. I'm going to give you and your partner a draft report to read and a peer-review guide to fill out. You two will then read the report together. Once you are done reading the report, I want you to answer each of the questions on the peer-review guide." Point to the review questions on the image of the PRG.
   - *If using the workbook,* tell the students, "I'm going to ask you to work with a partner to do this. I'm going to give you and your partner a draft report to read. You two will then read the report together. Once you are done reading the report, I want you to answer each of the questions on the peer-review guide that is right after the report in the investigation log." Point to the review questions on the image of the PRG.
6. Tell the students, "You can check 'yes,' 'almost,' or 'no' after each question." Point to the checkboxes on the image of the PRG.
7. Tell the students, "This will be your rating for this part of the report. Make sure you agree on the rating you give the author. If you mark 'almost' or 'no,' then you need to tell the author what he or she needs to do to get a 'yes.'" Point to the space for the reviewer feedback on the image of the PRG.
8. Tell the students, "It is really important for you to give the authors feedback that is helpful. That means you need to tell them exactly what they need to do to make their reports better." Ask the students, "Do you have any questions about what you need to do?"
9. Answer any questions that come up.
10. Tell the students, "Please sit with a partner who is not in your current group." Allow the students time to sit with a partner.
11. Give the following instructions:
    - *If using the Investigation Handout,* tell the students, "Okay, I am now going to give you one report to read and one peer-review guide to fill out." Pass out one report to each pair. Make sure that the report you give a pair was not written by one of the students in that pair. Give each pair one PRG to fill out as a team.
    - *If using the workbook,* tell the students, "Okay, I am now going to give you one report to read." Pass out a workbook to each pair. Make sure that the workbook you give a pair is not from one of the students in that pair.
12. Tell the students, "Okay, I'm going to give you 15 minutes to read the report I gave you and to fill out the peer-review guide. Go ahead and get started."

13. Give the students 15 minutes to work. As they work, move around from pair to pair to check in and see how things are going, answer questions, and offer advice.
14. After 15 minutes pass, tell the students, "Okay, time is up." *If using the Investigation Handout*, say, "Please give me the report and the peer-review guide that you filled out." *If using the workbook,* say, "Please give me the workbook that you have."
15. Collect the Investigation Handouts and the PRGs, or collect the workbooks if they are being used. Be sure you keep the handout and the PRG together.
16. Give the following instructions:
    - *If using the Investigation Handout,* tell the students, "Okay, I am now going to give you a different report to read and a new peer-review guide to fill out." Pass out another report to each pair. Make sure that this report was not written by one of the students in that pair. Give each pair a new PRG to fill out as a team.
    - *If using the workbook,* tell the students, "Okay, I am now going to give you a different report to read." Pass out a different workbook to each pair. Make sure that the workbook you give a pair is not from one of the students in that pair.
17. Tell the students, "Okay, I'm going to give you 15 minutes to read this new report and to fill out the peer-review guide. Go ahead and get started."
18. Give the students 15 minutes to work. As they work, move around from pair to pair to check in and see how things are going, answer questions, and offer advice.
19. After 15 minutes pass, tell the students, "Okay, time is up." *If using the Investigation Handout,* say, "Please give me the report and the peer-review guide that you filled out." *If using the workbook,* say, "Please give me the workbook that you have."
20. Collect the Investigation Handouts and the PRGs, or collect the workbooks if they are being used. Be sure you keep the handout and the PRG together.

Stage 8: Revise the Report (30 minutes)

Your students will use either the Investigation Handout or the investigation log in the student workbook when revising the report. Except where noted below, the directions are the same whether using the handout or the log.

1. Give the following instructions:
    - *If using the Investigation Handout,* tell the students, "You are now going to revise your investigation report based on the feedback you get from your classmates. Please take out a pencil while I hand back your draft report and the peer-review guide."

- *If using the investigation log in the student workbook,* tell the students, "You are now going to revise your investigation report based on the feedback you get from your classmates. Please take out a pencil while I hand back your investigation logs."

2. *If using the Investigation Handout,* pass back the handout and the PRG to each student. *If using the investigation log,* pass back the log to each student.
3. Tell the students, "Please take a few minutes to read over the peer-review guide. You should use it to figure out what you need to change in your report and how you will change the report."
4. Allow the students time to read the PRG.
5. *If using the investigation log,* if possible use a document camera to project the "Write Your Final Report" section from the investigation log on a screen or board (or take a picture of it and project the picture on a screen or board).
6. Give the following instructions:
   - *If using the Investigation Handout,* tell the students, "Okay. Let's revise our reports. Please take out a piece of paper. I would like you to rewrite your report. You can use your draft report as a starting point, but use the feedback on the peer-review guide to help make it better."
   - *If using the investigation log,* tell the students, "Okay. Let's revise our reports. I would like you to rewrite your report in the section of the investigation log that says 'Write Your Final Report.'" Point to the image on the screen and tell the students, "You can use your draft report as a starting point, but use the feedback on the peer-review guide to help make your report better."

   Ask the students, "Do you have any questions about what you need to do?"
7. Answer any questions that come up.
8. Tell the students, "Okay. Let's write."
9. Give the students 30 minutes to rewrite their report. As they work, move from student to student to check in, ask probing questions, and offer a suggestion if a student gets stuck.
10. Give the following instructions:
    - *If using the Investigation Handout,* tell the students, "Okay. Time's up. I will now come around and collect your Investigation Handout, the peer-review guide, and your final report."
    - *If using the investigation log,* tell the students, "Okay. Time's up. I will now come around and collect your workbooks."
11. *If using the Investigation Handout,* collect all the Investigation Handouts, PRGs, and final reports. *If using the investigation log,* collect all the workbooks.

12. *If using the Investigation Handout,* use the "Teacher Score" columns in the PRG to grade the final report. *If using the investigation log,* use the "ADI Investigation Report Grading Rubric" in the investigation log to grade the final report. Whether you are using the handout or the log, you can give the students feedback about their writing in the "Teacher Comments" section.

How to Use the Checkout Questions

The Checkout Questions are an optional assessment. We recommend giving them to students one day after they finish stage 8 of the ADI investigation. The Checkout Questions can be used as a formative or summative assessment of student thinking. If you plan to use them as a formative assessment, we recommend that you look over the student answers to determine if you need to reteach the core idea and/or crosscutting concept from the investigation, but do not grade them. If you plan to use them as a summative assessment, we have included a "Teacher Scoring Rubric" at the end of the Checkout Questions that you can use to score a student's ability to apply the core idea in a new scenario and explain their use of a crosscutting concept. The rubric includes a 4-point scale that ranges from 0 (the student cannot apply the core idea correctly in all cases and cannot explain the [crosscutting concept]) to 3 (the student can apply the core idea correctly in all cases and can fully explain the [crosscutting concept]). The Checkout Questions, regardless of how you decide to use them, are a great way to make student thinking visible so you can determine if the students have learned the core idea and the crosscutting concept.

A student who can apply the core idea correctly in all cases and can explain the cause-and-effect relationships would give the following answers for question 1: A, 8–10 wolves; B, 4–6 wolves; C, 4–6 wolves or 1–2 wolves (either answer is correct for C); and D, 1–2 wolves. He or she should then be able to explain that more wolves hunting together can catch and kill larger prey.

Connections to Standards

Table 6.2 (p. 238) highlights how the investigation can be used to address specific performance expectations from the *NGSS, Common Core State Standards (CCSS)* in English language arts (ELA) and in mathematics, and *English Language Proficiency (ELP) Standards.*

TABLE 6.2

Investigation 6 alignment with standards

***NGSS* performance expectation**	Strong alignment • 3-LS2-1: Construct an argument that some animals form groups that help members survive.
***CCSS ELA*—Reading: Informational Text**	Key ideas and details • CCSS.ELA-LITERACY.RI.3.1: Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. • CCSS.ELA-LITERACY.RI.3.2: Determine the main idea of a text; recount the key details and explain how they support the main idea. • CCSS.ELA-LITERACY.RI.3.3: Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. Craft and structure • CCSS.ELA-LITERACY.RI.3.4: Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade 3 topic or subject area*. • CCSS.ELA-LITERACY.RI.3.5: Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. • CCSS.ELA-LITERACY.RI.3.6: Distinguish their own point of view from that of the author of a text. Integration of knowledge and ideas • CCSS.ELA-LITERACY.RI.3.7: Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur). • CCSS.ELA-LITERACY.RI.3.8: Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence). • CCSS.ELA-LITERACY.RI.3.9: Compare and contrast the most important points and key details presented in two texts on the same topic. Range of reading and level of text complexity • CCSS.ELA-LITERACY.RI.3.10: By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text complexity band independently and proficiently.

Continued

Table 6.2 (*continued*)

***CCSS ELA*—Writing**	Text types and purposes
	• CCSS.ELA-LITERACY.W.3.1: Write opinion pieces on topics or texts, supporting a point of view with reasons.
	  ○ CCSS.ELA-LITERACY.W.3.1.A: Introduce the topic or text they are writing about, state an opinion, and create an organizational structure that lists reasons.
	  ○ CCSS.ELA-LITERACY.W.3.1.B: Provide reasons that support the opinion.
	  ○ CCSS.ELA-LITERACY.W.3.1.C: Use linking words and phrases (e.g., *because*, *therefore*, *since, for example*) to connect opinion and reasons.
	  ○ CCSS.ELA-LITERACY.W.3.1.D: Provide a concluding statement or section.
	• CCSS.ELA-LITERACY.W.3.2: Write informative or explanatory texts to examine a topic and convey ideas and information clearly.
	  ○ CCSS.ELA-LITERACY.W.3.2.A: Introduce a topic and group related information together; include illustrations when useful to aiding comprehension.
	  ○ CCSS.ELA-LITERACY.W.3.2.B: Develop the topic with facts, definitions, and details.
	  ○ CCSS.ELA-LITERACY.W.3.2.C: Use linking words and phrases (e.g., *also*, *another*, *and*, *more*, *but*) to connect ideas within categories of information.
	  ○ CCSS.ELA-LITERACY.W.3.2.D: Provide a concluding statement or section.
	Production and distribution of writing
	• CCSS.ELA-LITERACY.W.3.4: With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.
	• CCSS.ELA-LITERACY.W.3.5: With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing.
	• CCSS.ELA-LITERACY.W.3.6: With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others.
	Research to build and present knowledge
	• CCSS.ELA-LITERACY.W.3.8: Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
	Range of writing
	• CCSS.ELA-LITERACY.W.3.10: Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Continued

Table 6.2 (*continued*)

CCSS ELA—**Speaking and Listening**	Comprehension and collaboration
	• CCSS.ELA-LITERACY.SL.3.1: Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 3 topics and texts*, building on others' ideas and expressing their own clearly.
	  ○ CCSS.ELA-LITERACY.SL.3.1.A: Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
	  ○ CCSS.ELA-LITERACY.SL.3.1.B: Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
	  ○ CCSS.ELA-LITERACY.SL.3.1.C: Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
	  ○ CCSS.ELA-LITERACY.SL.3.1.D: Explain their own ideas and understanding in light of the discussion.
	• CCSS.ELA-LITERACY.SL.3.2: Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
	• CCSS.ELA-LITERACY.SL.3.3: Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
	Presentation of knowledge and ideas
	• CCSS.ELA-LITERACY.SL.3.4: Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
	• CCSS.ELA-LITERACY.SL.3.6: Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification.

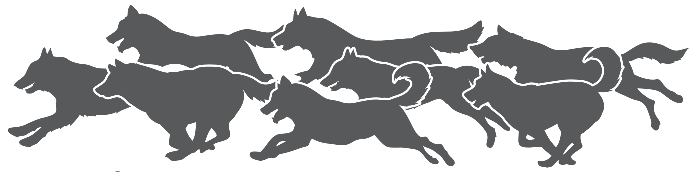
Continued

Table 6.2 (*continued*)

ELP Standards	Receptive modalities • ELP 1: Construct meaning from oral presentations and literary and informational text through grade-appropriate listening, reading, and viewing. • ELP 8: Determine the meaning of words and phrases in oral presentations and literary and informational text. Productive modalities • ELP 3: Speak and write about grade-appropriate complex literary and informational texts and topics. • ELP 4: Construct grade-appropriate oral and written claims and support them with reasoning and evidence. • ELP 7: Adapt language choices to purpose, task, and audience when speaking and writing. Interactive modalities • ELP 2: Participate in grade-appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions. • ELP 5: Conduct research and evaluate and communicate findings to answer questions or solve problems. • ELP 6: Analyze and critique the arguments of others orally and in writing. Linguistic structures of English • ELP 9: Create clear and coherent grade-appropriate speech and text. • ELP 10: Make accurate use of standard English to communicate in grade-appropriate speech and writing.

Investigation 6

Life in Groups: Why Do Wolves Live in Groups?



Introduction

All animals must eat to survive. Some animals eat plants, and some animals eat other animals. The musk ox is an example of an animal that eats plants. The arctic wolf is an example of an animal that eats other animals. Both of these animals live in the Arctic tundra. Arctic wolves often eat musk oxen ("oxen" means more than one ox). Take a few minutes to watch what happens when a group of wolves attacks a group of musk oxen. As you watch the video, keep track of what you observe and what you are wondering about in the boxes below.

Things I OBSERVED …	Things I WONDER about …

Many different kinds of animals live in groups. Insects often live with other insects in a colony. Fish often travel together in schools. Birds live with other birds in colonies and fly in flocks. Mammals often group together into packs or herds. The size of these groups can range from two or three animals to many thousands of animals.

Wolves are an example of an animal that lives in a group. Scientists often observe 5 to 15 wolves living together for long periods of time. The groups are called wolf packs. There are many potential reasons that may explain why animals, such as wolves, live in a group rather than alone. For example, groups of animals can work together to find food, raise young, or deal with changes in the environment. All of these reasons could make it easier for an animal to survive. Not all animals, however, live in groups. Some animals spend most of their life alone. Therefore, it is important for us to determine why it is a benefit or why it is not a benefit for animals to live as part of a group.

In this investigation you will watch several videos of wolves hunting different types of prey such as caribou, elk, and bison. These three different types of animals are not all the same size. An adult caribou weighs between 200 and 400 pounds, an adult elk weighs between 500 and 700 pounds, and an adult bison weighs between 1,300 and 1,500 pounds. Young caribou, elk, and bison, however, weigh much less.

Your goal in this investigation is to figure out if living in a group (the cause) makes it easier for wolves to get the food they need to survive (the effect). To accomplish this goal, you will need to look for a potential cause-and-effect relationship. Scientists often look for cause-and-effect relationships like this to help explain their observations. You can therefore look for a cause-and-effect relationship to help explain why wolves live in groups.

Things we KNOW from what we read …	What we will NEED to figure out …

Your Task

Use what you know about predators, prey, patterns, and cause-and-effect relationships to design and carry out an investigation to figure out if wolves benefit from hunting in a group.

The *guiding question* of this investigation is, ***Why do wolves live in groups?***

Materials

You will use a computer or tablet with internet access to watch the following videos during your investigation:

- Video showing wolves hunting caribou
- Video showing wolves hunting elk
- Video showing wolves hunting caribou
- Video showing gray wolves chasing down elk
- Video showing baby bison taking on a wolf
- Video showing wolves hunting buffalo
- Video showing wolves taking down elk
- Video showing bison and her calf battling wolves

Safety Rules

Follow all normal safety rules.

Plan Your Investigation

Prepare a plan for your investigation by filling out the chart that follows; this plan is called an *investigation proposal*. Before you start developing your plan, be sure to discuss the following questions with the other members of your group:

- What types of **patterns** might we look for to help answer the guiding question?
- What information do we need to find a **cause-and-effect relationship?**

Our guiding question:

We will collect the following data from the videos:

These are the steps we will follow to collect data as we watch the videos:

I approve of this investigation proposal.

Teacher's signature

Date

Collect Your Data

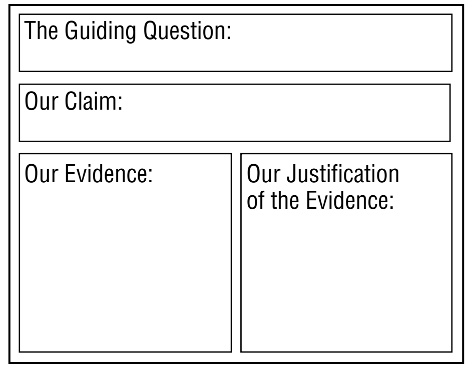
Keep a record of what you observe as you watch the videos in the space below.

Analyze Your Data

You will need to analyze the data you collected while watching the videos before you can develop an answer to the guiding question. In the space below, you can create a table or graph to show the outcomes of the different hunts.

Draft Argument

Develop an argument on a whiteboard. It should include the following parts:



1. A *claim:* Your answer to the guiding question.
2. *Evidence:* An analysis of the data and an explanation of what the analysis means.
3. A *justification of the evidence:* Why your group thinks the evidence is important.

Argumentation Session

Share your argument with your classmates. Be sure to ask them how to make your draft argument better. Keep track of their suggestions in the space below.

Ways to IMPROVE our argument …

Draft Report

Prepare an *investigation report* to share what you have learned. Use the information in this handout and your group's final argument to write a *draft* of your investigation report.

Introduction

We have been studying ______________________________ in class.

Before we started this investigation, we explored ______________________________

____

____

We noticed ______________________________

____

____

My goal for this investigation was to figure out ______________________________

____

____

The guiding question was ______________________________

____

____

Method

To gather the data I needed to answer this question, I ______________________________

____

____

____

____

____

I then analyzed the data I collected by ____

____

____

____

____

Argument

My claim is ____

____

____

The ____________________ below shows ____

____

____

____

This evidence is important because ____

____

____

____

____

____

____

____

Review

Your friends need your help! Review the draft of their investigation reports and give them ideas about how to improve. Use the *peer-review guide* when doing your review.

Submit Your Final Report

Once you have received feedback from your friends about your draft report, create your final investigation report and hand it in to your teacher.

Checkout Questions

Investigation 6. Life in Groups: Why Do Wolves Live in Groups?

1. Pictured below are four different animals. Circle the number of wolves that you think would need to hunt together to catch and eat that animal.

A.

Adult moose
1,600–1,800 pounds

1–2 4–6 8–10

B.

Adult caribou
200–400 pounds

1–2 4–6 8–10

C.

Adult white-tailed deer
80–100 pounds

1–2 4–6 8–10

D.

Baby moose
50–80 pounds

1–2 4–6 8–10

2. Explain your thinking. What *cause-and-effect relationship* did you use to determine how many wolves would need to hunt together to catch and eat an animal?

____

____

____

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____

Teacher Scoring Rubric for the Checkout Questions

Level	Description
3	The student can apply the core idea correctly in all cases and can fully explain the cause-and-effect relationship.
2	The student can apply the core idea correctly in all cases but cannot fully explain the cause-and-effect relationship.
1	The student cannot apply the core idea correctly in all cases but can fully explain the cause-and-effect relationship.
0	The student cannot apply the core idea correctly in all cases and cannot explain the cause-and-effect relationship.

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Argument-Driven Inquiry in Third-Grade Science

Three-Dimensional Investigations

Are you interested in using argument-driven inquiry (ADI) for elementary instruction but just aren't sure how to do it? You aren't alone. *Argument-Driven Inquiry in Third-Grade Science* will provide you with both the information and instructional materials you need to start using this method right away. The book is a one-stop source of expertise, advice, and investigations. It's designed to help your third graders work the way scientists do while integrating literacy and math at the same time.

Argument-Driven Inquiry in Third-Grade Science is divided into two basic parts:

1. **An introduction to the stages of ADI**—from question identification, data analysis, and argument development to evaluating and revising ideas.
2. **A well-organized series of 14 field-tested investigations** designed to be much more authentic for instruction than traditional activities. The investigations cover five disciplinary core ideas: motion and stability; molecules and organisms; heredity; biological evolution; and Earth's systems. Using the *Student Workbook,* your class will explore important content and discover scientific practices. They can investigate questions such as these: What types of objects are attracted to a magnet? Why do wolves live in groups? And what was the ecosystem like 49 million years ago in Darmstadt, Germany?

This book is part of NSTA's best-selling series about ADI in middle school and high school science. Like its predecessors, this collection is designed to be easy to use, with teacher notes, investigation handouts, and checkout questions. The lessons also support the *Next Generation Science Standards* and the *Common Core State Standards* in English language arts and mathematics. The book can also help emerging bilingual students meet the *English Language Proficiency Standards*.

Many of today's elementary school teachers—like you—want new ways to engage students in scientific practices and help students learn more from classroom activities. *Argument-Driven Inquiry in Third-Grade Science* does all of this while giving students the chance to practice reading, writing, speaking, and using mathematics in the context of science.

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