Argument-Driven Inquiry in Third-Grade Science

Three-Dimensional Investigations

Victor Sampson and Ashley Murphy

NSTA press
National Science Teachers Association

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Contents

Contents

SECTION 3 - From Molecules to Organisms: Structures and Process

SECTION 4 - Heredity: Inheritance and Variation of Traits

SECTION 5 - Biological Evolution: Unity and Diversity

Contents

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.

References

Bybee, R. W., and S. Pruitt. 2017. *Perspectives on science education: A leadership seminar.* Arlington, VA: NSTA Press.

Council of Chief State School Officers (CCSSO). 2014. *English language proficiency (ELP) standards.* Washington, DC: NGAC and CCSSO. *www.ccsso.org/resource-library/english-language-proficiency-elp-standards.*

National Governors Association Center for Best Practices and Council of Chief State School Officers (NGAC and CCSSO). 2010. *Common core state standards.* Washington, DC: NGAC and CCSSO.

National Research Council (NRC). 2012. *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.

NGSS Lead States. 2013. *Next Generation Science Standards: For states, by states.* Washington, DC: National Academies Press. *www.nextgenscience.org/next-generation-science-standards*.

Sampson, V., and A. Murphy. Forthcoming. *Argument-driven inquiry in fifth-grade science: Three-dimensional investigations*. Arlington, VA: NSTA Press.

Sampson, V., and A. Murphy. Forthcoming. *Argument-driven inquiry in fourth-grade science: Three-dimensional investigations*. Arlington, VA: NSTA Press.

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Investigation 14

Climate and Location: How Does the Climate Change as One Moves From the Equator Toward the Poles?

Purpose

The purpose of this investigation is to give students an opportunity to use the disciplinary core idea (DCI) of ESS2.D: Weather and Climate along with the crosscutting concept (CC) of Patterns from *A Framework for K–12 Science Education* (NRC 2012) to figure out how latitude affects climate. Students will also learn about how scientific knowledge can change over time during the reflective discussion.

The Disciplinary Core Idea

Students in third grade should understand the following about the Weather and Climate and be able to use this DCI to figure out how latitude affects climate:

> *Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (NRC 2012, p. 188)*

The Crosscutting Concept

Students in third grade should understand the following about the CC Patterns:

> *Noticing patterns is often a first step to organizing and asking scientific questions about why and how the patterns occur. One major use of pattern recognition is in classification, which depends on careful observation of similarities and differences; objects can be classified into groups on the basis of similarities of visible or microscopic features or on the basis of similarities of function. Such classification is useful in codifying relationships and organizing a multitude of objects or processes into a limited number of groups. (NRC 2012, p. 85)*

Students in third grade should be given opportunities to "describe and predict the patterns in the seasons of the year" (NRC 2012, p. 86).

Students should be encouraged to use their developing understanding of patterns as a tool or a way of thinking about a phenomenon during this investigation to help them figure out how latitude affects climate.

What Students Figure Out

Climate describes the range of the typical weather conditions and how much variation there is in the conditions at a specific location over long periods of time. Latitude affects climate. Cities located near the poles have a larger seasonal temperature range than cities located near the equator. Cities near the equator also tend to have higher amounts of annual precipitation.

Timeline

The time needed to complete this investigation is 285 minutes (4 hours and 45 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: 50 minutes
- *Stage 2.* Design a method and collect data: 60 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 14.1 (p. 512). Students will need access to a computer or tablet with an internet connection to collect data about the typical weather for each city from the World Weather and Climate Information website at *https://weather-and-climate.com*. 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. Be sure to visit the website and learn how to find the information that the students will need before starting the investigation so you can show students how to use it and help them when they get stuck. In addition, it is important to check if students can access and use the website from a school computer or tablet, because some schools have set up firewalls and other restrictions on web browsing.

TABLE 14.1

Materials for Investigation 14

Item	Quantity
Computer or tablet with internet access	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 (50 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 14 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 students how to use the grid lines to identify the *latitude* (the distance north or south from the equator) and *longitude* (the distance east or west of the *prime meridian,* which is an imaginary line running from north to south through Greenwich, England) of one of the cities on the map.
6. Tell students to find the latitude and longitude of the remaining cities on the map and then record their observations and questions about the cities in the "NOTICED/WONDER" chart in the "Introduction" section of their Investigation Handout (or the investigation log in their workbook).
7. Give the students 10 minutes to find the latitude and longitude of the remaining cities and record their observations and questions.
8. After the students have recorded their observations and questions, ask students to share *what they noticed* about the cities.
9. Ask students to share *what questions they have* about the cities.

10. Tell the students, "Some of your questions might be answered by reading the rest of the 'Introduction.'"
11. Ask the students to read the rest of the "Introduction" on their own *or* ask them to follow along as you read aloud.
12. 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.
13. Ask students to share what they learned from the reading. Add these ideas to a class "know / need to figure out" chart.
14. 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.
15. Tell the students, "It looks like we have something to figure out. Let's see what we will need to do during our investigation."
16. Read the task and the guiding question aloud.
17. Tell the students, "You will be able to use a website called World Weather and Climate Information during your investigation."
18. Show the students how to use the website by projecting it on the board or on a screen and demonstrating how to select a country and a city in that country and then find the data they need.
19. Remind students of the safety rules and precautions for this investigation.

Stage 2: Design a Method and Collect Data (60 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 information should we collect so we can *describe* the climate of a city?
   - What types of *patterns* might we look for to help answer the guiding question?
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:" and tell the students, "You can list the measurements or 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:" 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.
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. Tell 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).
16. Give the students 20 minutes to collect their data.

What should a student-designed investigation look like?

The students' investigation proposal should include the following information:

- The guiding question is "How does the climate change as one moves from the equator toward the poles?"
- There are a lot of different types of data that students can collect during this investigation. Students can collect data about (1) average monthly maximum temperature, (2) average monthly minimum temperature, (3) average monthly precipitation, (4) average monthly relative humidity, and (5) average mean wind speed. At a minimum, each group should collect data about two different weather measurements. This investigation works best if each group selects different measurements used to describe the climate of a city.
- The steps that the students will follow to collect the data should reflect the measurements that they decide to examine. However, a procedure might include the following steps: (1) identify two cities, (2) record typical [weather condition 1] for each month in both cities, (3) record typical [weather condition 2] for each month in both cities, and (4) compare how these values change by month in each city. There should be a lot of variation in the student-designed investigations.

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" section 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 section and tell the students, "You can create a couple of graphs as a way to analyze your data. You can make your graphs in this section."
3. Ask the students, "What information do we need to include in these graphs?"
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 your graphs." If the students are having

trouble making a graph, you can take a few minutes to provide a mini-lesson about how to create a 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 graph look like for this investigation?

There are a number of different ways that students can analyze the observations or measurements they collect during this investigation. One of the most straightforward ways is to create a scaled bar graph, one for each weather measurement (e.g., high temperature, low temperature, humidity, wind speed, precipitation). Each bar graph should have categories for each month on the horizontal or *x*-axis. The average value for a weather condition (e.g., average high temperature, average low temperature, average humidity, average wind speed, average precipitation) should be on the *y*-axis. An example of this type of graph can be seen in Figure 14.1.

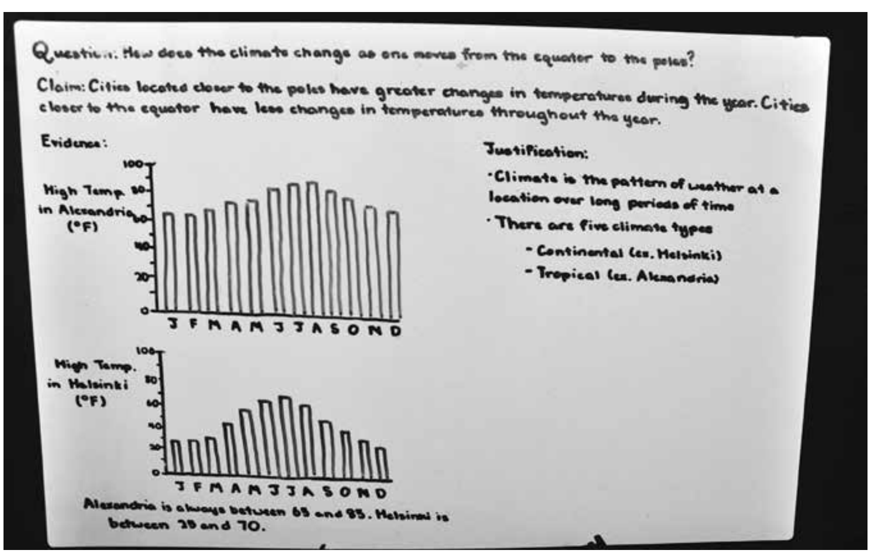
8. Give the students 10 minutes to analyze their data. As they work, move from group to group to check in, ask probing questions, and offer suggestions.
9. Tell the students, "I am now going to give you and the other members of your group 15 minutes to create an argument to share what you have learned 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 14.1 shows an example of an argument created by students for this investigation.

FIGURE 14.1

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."

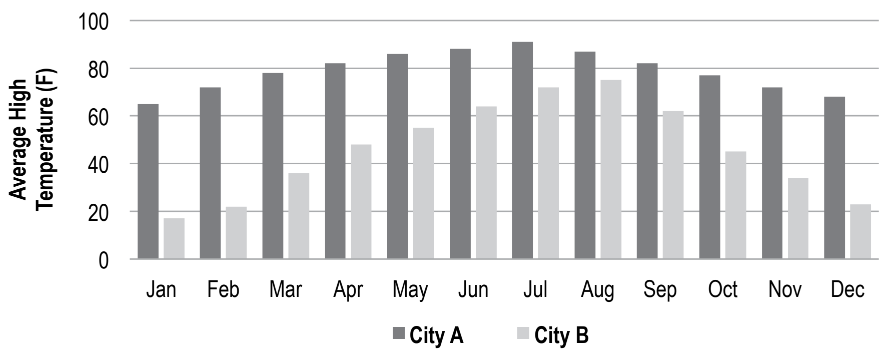
   Ask the students, "Do you have any questions about what you need to do?"
10. Answer any questions that come up.
11. Tell the students, "Okay. Let's get started."
12. Give the students 10 minutes to work in their groups on their arguments. As they work, move from group to group to check in, ask probing 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 14.2 on a screen. This is a graph showing the average high temperature changes by month in two different cities. Ask the students, "What do you all see going on here?"

FIGURE 14.2

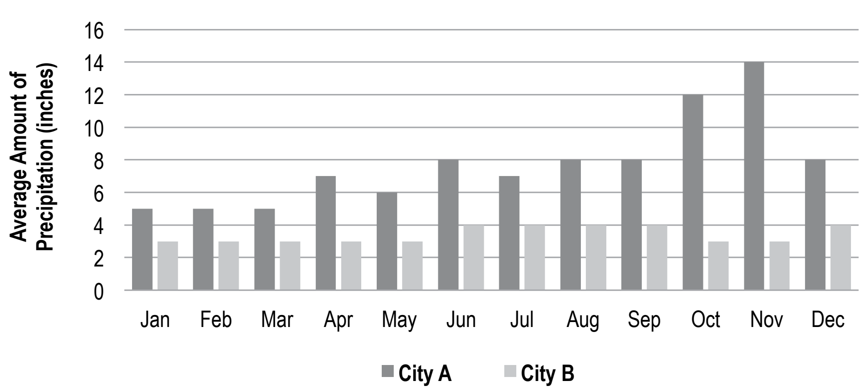
Average high temperature by month in two different cities



3. Allow students to share their ideas.
4. Ask the students, "Which city do you think is located closer to the equator, and how do you know?"
5. Allow students to share their ideas.
6. Show Figure 14.3 on the screen. This is a graph showing how the average amount of precipitation changes by month in the same two cities.

FIGURE 14.3

Average amount of precipitation by month in two different cities



7. Ask the students, "What do you all see going on here?"
8. Allow students to share their ideas.
9. Ask the students, "What type of climate do you think city A has, and how do you know?"
10. Allow students to share their ideas.
11. Ask the students, "What type of climate do you think city B has, and how do you know?"
12. Allow three or four different students to share their ideas.
13. Tell the students, "Okay, let's make sure we are on the same page. Climate describes the range of the typical weather conditions and how much variation there is in the conditions at a specific location over long periods of time. Latitude affects climate. Cities located near the North Pole or the South Pole have a larger seasonal temperature range than cities located near the equator. Cities near the equator also tend to have higher amounts of annual precipitation. This description of climate and how we can predict the climate of different cities based on where they are located is a really important core idea in science."
14. Ask the students, "Does anyone have any questions about this core idea?"
15. Answer any questions that come up.
16. Tell the students, "We also looked for patterns during our investigation." Then show Figures 14.2 and 14.3 (p. 521) on the screen for a second time.
17. Ask the students, "What pattern do you see here?"
18. Allow students to share their ideas.
19. Tell the students, "Patterns are really important in science. Scientists look for patterns all the time and use them to make predictions. In fact, they even use patterns in the weather to describe climates, just like we did."
20. 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."
21. 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.
22. Ask the students, "What do you all think? Who would like to share an idea?"
23. Allow students to share their ideas. Be sure to expand on their ideas about what makes an investigation scientific.

24. 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.
25. Ask the students, "What do you all think? Who would like to share an idea?"
26. Allow students to share their ideas. Be sure to expand on their ideas about what makes an investigation less scientific.
27. 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.
28. Ask the students, "What do you all think? Who would like to share an idea?"
29. Allow students to share their ideas. Once they have shared their ideas, offer a suggestion for a possible class rule.
30. Ask the students, "What do you all think? Should we make this a rule?"
31. 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.
32. Tell the students, "We are now going take a minute to talk about what makes science different from other subjects."
33. Show an image of the question "Does scientific knowledge ever change?" 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.
34. Ask the students, "What do you all think? Who would like to share an idea?"
35. Allow three or four students to share their ideas.
36. Tell the students, "Okay, these are all great ideas. Always remember that scientific knowledge can change as scientists collect and analyze more data. For example, the way we describe the climate of Helsinki or Izmir may change if the patterns in the weather measurements that they collect change over time. That is another characteristic of scientific knowledge—it is based on evidence. So, if what scientists currently know about something is no longer supported by what they observe or measure, then scientists change what they know."
37. Ask the students, "Does anyone have any questions about how scientific knowledge can change over time?"
38. 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, be sure to 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 pattern would give the following answers: question 1, city A; question 2, city A; question 3, continental; and question 4, tropical. He or she should then be able to explain that latitude affects climate, so cities located near the equator tend to be warmer all year round and have more annual precipitation than cities located farther from the equator.

Connections to Standards

Table 14.2 (p. 530) 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 14.2

Investigation 14 alignment with standards

***NGSS* performance expectation**	Strong alignment • 3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.
***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 14.2 (*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 14.2 (*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.

***CCSS Mathematics*— Measurement and Data**	Represent and interpret data • CCSS.MATH.CONTENT.3.MD.B.3: Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs.

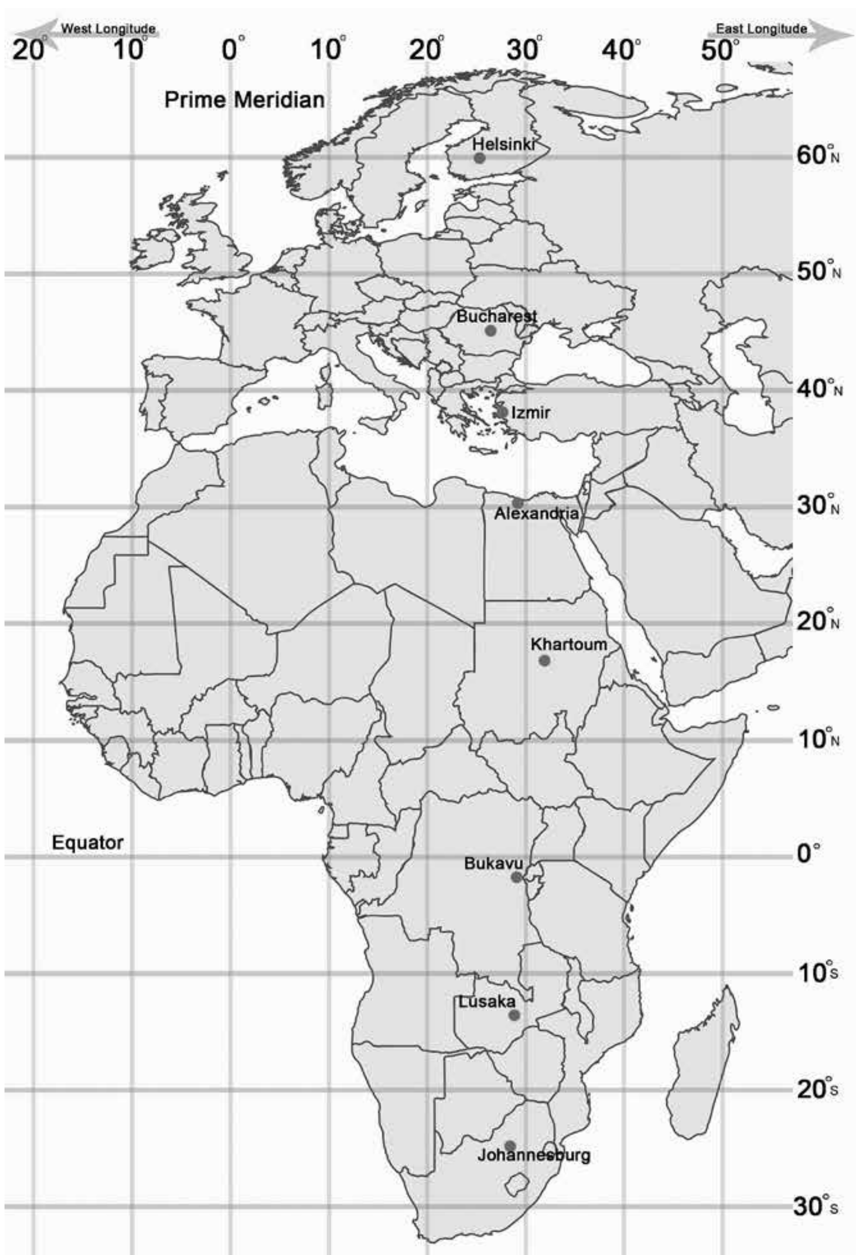
Continued

Table 14.2 (*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 14

Climate and Location: How Does the Climate Change as One Moves From the Equator Toward the Poles?



Introduction

There are many cities all over the world. All of these cities have characteristics that make them special. Take a minute to find the latitude and longitude of the eight different cities labeled on the map on the previous page. Keep track of what you notice and what you are wondering about in the boxes below.

City	Longitude	Latitude
Helsinki, Finland		
Bucharest, Romania		
Izmir, Turkey		
Alexandria, Egypt		

City	Longitude	Latitude
Khartoum, Sudan		
Bukavu, Democratic Republic of the Congo		
Lusaka, Zambia		
Johannesburg, South Africa		

Things I NOTICED …	Things I WONDER about …

People often want to know about the climate and the current weather in a city before they travel to that city so they know what type of clothing to bring with them. *Climate* is a pattern of weather in a particular region over a long period of time. *Weather* is the current condition of the atmosphere at a specific place. We describe the weather by measuring the air temperature, humidity, wind speed, precipitation, and cloud cover. Weather can change from hour to hour or day to day.

A region's weather patterns, tracked for more than 30 years, are used to describe the climate of that region. There are five main climate types:

- *Tropical*—a region that is warm all year and gets a lot of rain
- *Dry*—a region that gets very little rain; it can be hot or cool
- *Mild*—a region with warm and dry summers and short, cool, but rainy winters
- *Continental*—a region with short summers and long winters that are cold with a lot of snow
- *Polar*—a region with temperatures that are cold all year

There are many reasons why different regions have different climates. One cause that may or may not affect the climate of a specific region is *latitude,* or how far that specific region is from the equator. Think about the eight cities shown on the map. These cities are all located at between about 25 and 30 East longitude, but each city is at a different latitude. *Longitude* is the distance east or west of the *prime meridian* (an imaginary line running from north to south through Greenwich, England). Some of the cities, in other words, are close to the equator and some are far away from the equator, even though all these cities are found on the same side of the Earth.

Your goal in this investigation is to first determine if these cities have different climates and then use this information to figure out if the climate at a specific location is related to how far it is from the equator. To accomplish this task, you will need to compare how the typical weather in at least two of these cities changes by month over an entire year. You can then use this information to look for a pattern. If you can find a pattern, you will be able to figure out how latitude and climate are related.

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

Your Task

Use what you know about weather, climate, and patterns to determine the climate of at least two different cities that are located at a similar longitude but different latitudes. Then determine if there is a relationship between latitude and climate.

The *guiding question* of this investigation is, ***How does the climate change as one moves from the equator toward the poles?***

Materials

You will use a computer or tablet with internet access and a website called World Weather and Climate Information during your investigation. The website is at *https://weather-and-climate.com.*

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 information should we collect so we can **describe** the climate of a city?
- What types of **patterns** might we look for to help answer the guiding question?

Our guiding question:

We will collect the following data:

These are the steps we will follow to collect data:

I approve of this investigation proposal.

Teacher's signature

Date

Collect Your Data

Keep a record of what you measure or observe during your investigation in the space below.

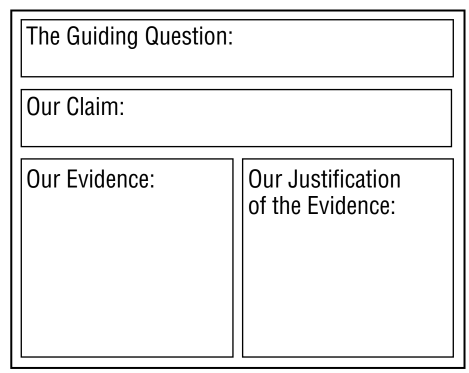
Analyze Your Data

You will need to analyze the data you collected before you can develop an answer to the guiding question. In the space that follows, create two graphs to illustrate how the climate of each city is different.

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 ________________________________

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I then analyzed the data I collected by ______________________________________

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Argument

My claim is ______________________________________

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Figure 1 below shows ______________________________________

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Figure 2 below shows ____

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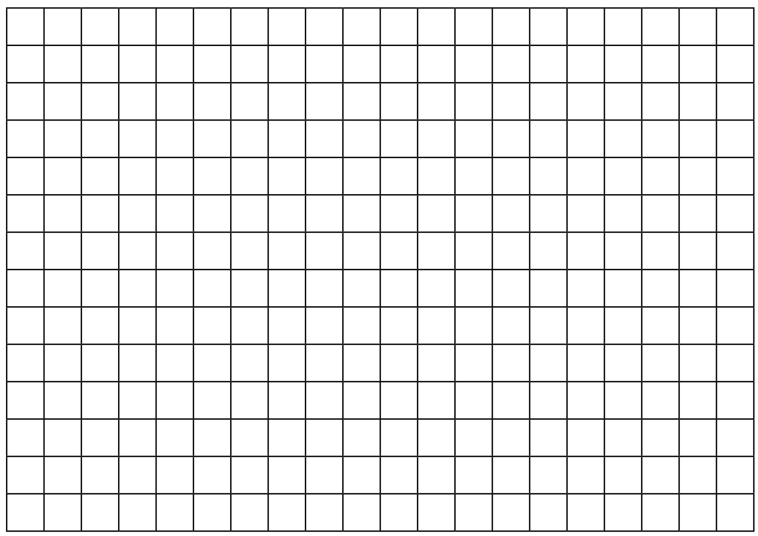

This evidence is important because ____

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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.

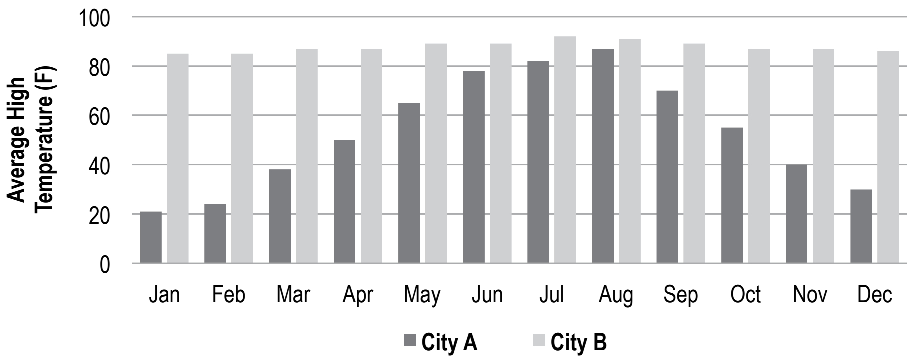
Submit Your Final Report

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 14. Climate and Location: How Does the Climate Change as One Moves From the Equator Toward the Poles?

The graph below shows the average high temperature by month in two different cities. Both cities are located on the same line of longitude in the Western Hemisphere.



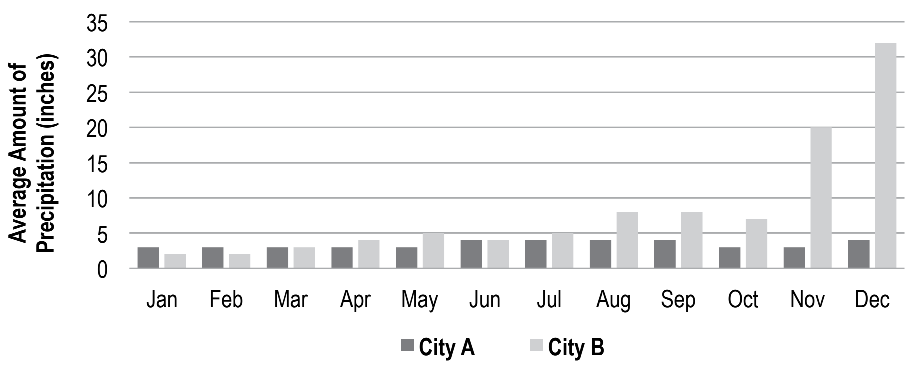
1. Which city has the greatest change in seasonal temperature?

   ☐ City A ☐ City B

2. Which city is most likely located farthest from the equator?

   ☐ City A ☐ City B

The graph below shows the average amount of precipitation by month in these two cities.



3. How would you describe the climate in city A based on all the information available?

   ☐ Tropical ☐ Continental

   ☐ Dry ☐ Polar

   ☐ Mild

4. How would you describe the climate in city B based on all the information available?

☐ Tropical ☐ Continental

☐ Dry ☐ Polar

☐ Mild

5. Explain your thinking. What *pattern* from your investigation did you use to determine the location and climate of these two cities?

____
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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 pattern.
2	The student can apply the core idea correctly in all cases but cannot fully explain the pattern.
1	The student cannot apply the core idea correctly in all cases but can fully explain the pattern.
0	The student cannot apply the core idea correctly in all cases and cannot explain the pattern.

INDEX

Page numbers printed in **boldface type** refer to figures or tables.

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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