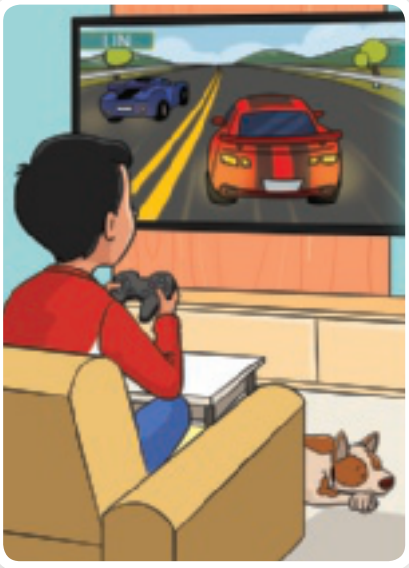
Core Knowledge® SCIENCE

Problem-Solving and Computers

Homework

Teacher Guide

Fun



Communication

Schoolwork

Problem-Solving and Computers

Teacher Guide

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Problem-Solving and Computers

Table of Contents

Problem-Solving and Computers

Teacher Guide

Core Knowledge Computer Science™ 4

GRADE 4

Introduction

About this Program

Core Knowledge Computer Science Conceptual Approach Framework

Grade	Title and Driving Question	Emphasis is on . . .	Overarching Unit Objective
K (ages 5–6)	**Computers All Around Us** What are computers, and where can we find them?	recognizing	Identify computer devices and parts, and operate them age-appropriately.
1 (ages 6–7)	**Helpful Computers** What can computer programs do?	using	Experience a variety of age-appropriate programs designed for different purposes.
2 (ages 7–8)	**Using Computers** How can we use computers and the internet?	using	Use a variety of age-appropriate programs and websites with increasing skill and independence under supervision.
3 (ages 8–9)	**Codes and Computers** How do programmers build computer programs?	deciphering and evaluating	Model use of symbols, codes, and steps in simple processes and problem-solving.
4 (ages 9–10)	**Problem-Solving and Computers** What kinds of problems can we solve with computers?	deciphering and evaluating	Model solution design in increasing complexity and involving conditionals and loops.
5 (ages 10–11)	**Designing Computer Programs** What kinds of computer programs can I develop?	planning and designing	Write, evaluate, and debug code to execute grade-appropriate tasks.

Skills and Performance Summary

Grade K

The goal of the instruction and cumulative experiences in this unit is for young students to build a concept of what makes a thing a computer. Students think about how tools and devices can be helpful for completing tasks. Though students will not specifically study simple and compound machines in science until a later grade level,

	they are able from everyday exposure to differentiate devices that need a power source and those that do not. Within the class of devices that need a power source, students can form a further classification of electronic devices—ones that do something with information that is put into the device. Upon recognizing input-processing-output characteristics of devices, students can also begin to classify and use devices for different purposes, including playing games, communicating, and doing schoolwork.
Grade 1	Building on the recognition established in the previous grade, the goal of the instruction and cumulative experiences in this unit is for young students to begin using computer devices for various purposes, including game play, communication, and schoolwork. Through practice, students understand that the operation of devices has a series of steps in common, in which users input information, the device performs a process, and then a useful output occurs. Inputs include the use of a mouse, keyboard, touchscreen, game controller, camera, and microphone. Output includes screen visuals (text, still images, video), hard-copy printout, and audio. Accessing desired outputs from computers depends first on successful operation of input devices.
Grade 2	Building on the use of devices established in the previous grade, the goal of the instruction and cumulative experiences in this unit is for young students to continue using with increasing independence computer devices for various purposes, including game play, communication, and schoolwork. With increasing practice in successfully inputting information, students can consider ways to achieve creative outputs that use and combine text, graphics, visual data displays, photos, animations, video, and audio.
Grade 3	In this grade level, the emphasis begins to shift from use—skillfully inputting information to prompt outputs—to the unseen processes inside computing technology. The goal of the instruction and cumulative experiences in this unit is for students to identify the output of every computer device as a solution to a problem and deconstruct the solution into the necessary steps required. Students discern that computers do not think on their own to solve problems but only execute step-by-step instructions that are built into them. And students begin to dissect messages into the granular parts that make them up and transmit them.
Grade 4	Building on the concepts of symbols, codes, signals, and step-by-step instructions established in the previous grade, the goal of the instruction and cumulative experiences in this unit is for students to continue articulating steps of increasing complexity to solve problems. Beyond dissecting solutions into granular steps, students think forward in scenarios with conditional branching options (if-then statements) and loops (if-then, repeat prior instruction). Students relate what computing devices do to their programming, and they build understanding that complex computer programming is the outcome of building, layering, and chaining together links of fundamentally simple code.
Grade 5	In this grade level, the emphasis begins to shift from examination—figuring out how instructions make computing devices do what they do—to creative application of that knowledge. They step forward from the role of computer technology user into a beginning maker role. Students begin to use functional computer language to craft code for executable tasks.

Note to Teachers and Curriculum Planners

This unit introduces Grade 4 students to increasingly complex concepts related to computer programming. The unit includes a story-based Student Reader and this Teacher Guide. The lesson sessions alternate between those focused on the Student Reader and others that are interactive in nature and do not involve a Student Reader chapter.

This unit can be integrated into your existing science or math curriculum. The lessons can be inserted intermittently, or the entire unit can be taught on consecutive days. The unit can also be offered as an enrichment course.

Standards: What are the relevant CSTA Concepts for this unit?*

This unit, *Problem-Solving and Computers*, has been informed by the K–12 Computer Science Standards put forth by the Computer Science Teachers Association. The CSTA K–12 Computer Science Standards delineate a core set of learning objectives designed to provide the foundation for computer science curricula and implementation at the K–12 level. The CSTA Standards introduce fundamental concepts of computer science beginning at the elementary school level.

Online Resources

For detailed information about the CSTA references, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/ckcompsci-online-resources

Grades 3–5 CSTA Standards

Concepts	Subconcepts	Level 1B (ages 8–11) By the end of Grade 5, students will be able to . . .
Computing Systems	**Devices**	1B-CS-01 Describe how internal and external parts of computing devices function to form a system. (P7.2)
	Hardware and Software	1B-CS-02 Model how computer hardware and software work together as a system to accomplish tasks. (P4.4)
	Troubleshooting	1B-CS-03 Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies. (P6.2)

*The K–12 Computer Science Framework, led by the Association for Computing Machinery, Code.org, Computer Science Teachers Association, Cyber Innovation Center, and National Math and Science Initiative in partnership with states and districts, informed the development of this work. Authors of the CSTA K–12 Computer Science Standards were not involved in the production of this product, and their endorsement is not implied.

Sources:
Computer Science Teachers Association (2017). CSTA K-12 Computer Science Standards, Revised 2017. Retrieved from http://www.csteachers.org/standards.

K–12 Computer Science Framework. (2016). Framework view by grade band. Retrieved from http://www.k12cs.org

Concepts	Subconcepts	Level 1B (ages 8–11) By the end of Grade 5, students will be able to . . .
Networks and the Internet	**Network, Communication, and Organization**	1B-NI-04 Model how information is broken down into smaller pieces, transmitted as packets through multiple devices over networks and the Internet, and reassembled at the destination. (P4.4)
	Cybersecurity	1B-NI-05 Discuss real-world cybersecurity problems and how personal information can be protected. (P3.1)
Data and Analysis	**Storage**	(continuation) 1A-DA-05 Store, copy, search, retrieve, modify, and delete information using a computing device and define the information stored as data. (P4.2)
	Collection, Visualization, and Transformation	1B-DA-06 Organize and present collected data visually to highlight relationships and support a claim. (P7.1)
	Inference and Models	1B-DA-07 Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea. (P7.1)
Algorithms and Programming	**Algorithms**	1B-AP-08 Compare and refine multiple algorithms for the same task and determine which is the most appropriate. (P6.3, P3.3)
	Variables	1B-AP-09 Create programs that use variables to store and modify data. (P5.2)
	Control	1B-AP-10 Create programs that include sequences, events, loops, and conditionals. (P5.2)
	Modularity	1B-AP-11 Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process. (P3.2)
		1B-AP-12 Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features. (P5.3)
	Program Development	1B-AP-13 Use an iterative process to plan the development of a program by including others' perspectives and considering user preferences. (P1.1, P5.1)
		1B-AP-14 Observe intellectual property rights and give appropriate attribution when creating or remixing programs. (P7.3)
		1B-AP-15 Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended. (P6.1, P6.2)
		1B-AP-16 Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development. (P2.2)
		1B-AP-17 Describe choices made during program development using code comments, presentations, and demonstrations. (P7.2)

Concepts	Subconcepts	Level 1B (ages 8–11) By the end of Grade 5, students will be able to . . .
Impacts of Computing	**Culture**	1B-IC-18 Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by, cultural practices. (P7.1)
		1B-IC-19 Brainstorm ways to improve the accessibility and usability of technology products for the diverse needs and wants of users. (P1.2)
	Social Interactions	1B-IC-20 Seek diverse perspectives for the purpose of improving computational artifacts. (P1.1)
	Safety, Ethics, and Law	1B-IC-21 Use public domain or creative commons media, and refrain from copying or using material created by others without permission. (P7.3)

Integrated Practices

1. Fostering an Inclusive Computing Culture
    - 1.1 Include the unique perspectives of others . . .
    - 1.2 Address the needs of diverse end users . . .
    - 1.3 Employ self and peer-review advocacy . . .
2. Collaborating Around Computing
    - 2.1 Cultivate working relationships . . .
    - 2.2 Create team norms, expectations, and equitable workloads . . .
    - 2.3 Solicit and incorporate feedback . . .
    - 2.4 Evaluate and select technological tools . . .
3. Recognizing and Defining Computational Problems
    - 3.1 Identify complex, interdisciplinary, real-world problems . . .
    - 3.2 Decompose complex real-world problems . . .
    - 3.3 Evaluate whether it is appropriate and feasible . . .
4. Developing and Using Abstractions
    - 4.1 Extract common features . . .
    - 4.2 Evaluate existing technological functionalities . . .
    - 4.3 Create modules and develop points of interaction . . .
    - 4.4 Model phenomena and processes and simulate systems . . .

5. Creating Computational Artifacts

    5.1 Plan the development of a computational artifact . . .

    5.2 Create a computational artifact . . .

    5.3 Modify an existing artifact . . .

6. Testing and Refining Computational Artifacts

    6.1 Systematically test . . .

    6.2 Identify and fix errors . . .

    6.3 Evaluate and refine . . .

7. Communicating About Computing

    7.1 Select, organize, and interpret . . . data sets . . .

    7.2 Describe, justify, and document computational processes . . .

    7.3 Articulate ideas responsibly . . .

(See *K12 Computer Science Framework* for full text of the Practices integrated into the standards.)

What Teachers Need to Know

Supportive information on the content standards and the concepts they address is provided throughout the lessons at points of relevance:

Know the Standards: These sections, found later in this Teacher Guide, explain what to teach and why, with reference to CSTA and Core Knowledge expectations.

Know the Science: These sections provide supporting, adult-level, background information or explanations related to specific computer science concepts or examples.

A Special Note to Grade 4 Teachers Before Starting This Unit

Why Study Computer Science in the Elementary Grades?

For many elementary teachers, the suggestion that computer science should be a part of the Grade 4 curriculum may seem questionable. For many teachers, precious instructional time is devoted to teaching core content area fundamentals to students.

The study of computer science in Grade 4, however, is consistent with the Core Knowledge approach to learning. Knowledge builds upon knowledge, and computer science builds upon the foundational understanding that many devices

share basic underlying technology. And that technology operates through shared processes that are simple at their core but are combined in increasingly complex ways that can produce seemingly unlimited outcomes. Grade 4 students can build on what they learned in Kindergarten through Grade 3 to recognize that devices are operated by instructional coding. They can also consider step-by-step instructions, if-then scenarios, and simple codes that carry meaning. These building blocks promote readiness for students to put concepts together and make their own instructional codes in later elementary grades.

Using the Student Reader

Student Reader

The *Problem-Solving and Computers* Student Reader includes ten chapters and a student Glossary providing definitions to Core Vocabulary words. Engaging text and images encourage students to draw upon their own experiences and the world around them to understand unit concepts. In addition to Core Vocabulary, the Student Readers include a feature called Word to Know, which provides background information to help students understand key terms and may sometimes include additional informational boxes, such as Think About.

Read, then explore: In the Core Knowledge Computer Science program, lessons are sequenced for reading before active engagement. First, students are introduced to concepts through relatable scenarios in the Student Readers. Then students explore the concepts through hands-on investigations or teacher demonstrations, accompanied by active questioning and analysis. The icon shown at left will signal Core Lesson segments that focus on Student Reader chapters.

Independent reading or group read aloud: While the text in the Student Readers is written for independent reading, we encourage group read aloud and engagement with the text. The Teacher Guide provides Guided Reading Supports to prompt discussion, clarify misconceptions, and promote understanding in relation to the Driving Question and chapter topics.

Online Resources

Use this link to download the Online Resources for this unit, where the specific link to this appendix can be found:

www.coreknowledge.org/cksci-online-resources

Using the Teacher Guide

Instructional Design

The *Problem-Solving and Computers* unit is the Grade 4 installment in the Core Knowledge Computer Science elementary series. To meet CSTA Standards we encourage teachers to complete the corresponding grade-level unit each school year. Each lesson part requires thirty to forty-five minutes of instruction time. The time it takes to complete a full lesson depends on class size and individual circumstances.

Within the Teacher Guide, each Core Lesson is generally composed of two or three parts. Each segment concludes with a Check for Understanding, providing the teacher with a quick opportunity for formative assessment. At the end of this unit introduction, you will find a blank pacing guide, which you may use to plan how you might pace the lessons. We strongly recommend that you preview the unit in full before beginning instruction and that you create your pacing guide before teaching the first lesson.

Features

The unit is composed with several integrated features that support learning for all students and development for teachers.

Unplugged 	This Computer Science unit can be completed BOTH in classrooms that have computers and devices for students and those that do not. Look for the icons at left to indicate the types of student interactions recommended within each lesson. Pay attention to those icons most relevant to your classroom situation. There are many opportunities for students to complete foundational exercises relevant to the concepts of computer science without needing access to computers. These activities are designated by the Unplugged icon.
Device-Based 	Several activities and extensions do require that students work on computers, and those experiences are designated by the Device-Based icon.
Online Resources 	A few activities and demonstrations recommended in this unit require the use of internet-connected devices. These experiences are indicated by the Online icon and will also include references to the Online Resources Guide for links to the recommended internet resources.
Differentiation	Adjustments to instruction appear in the text, indicated by **SUPPORT**, **EXTEND**, and **CHALLENGE** notations. **SUPPORT**—Reading, writing, listening, and/or speaking alternatives appear for students who are English language learners, have special needs, or read below the grade level. Extra support is suggested for students who struggle to meet targeted expectations. **EXTEND**—Extensions are suggested for students with high interest or who have already met the performance expectations. **CHALLENGE**—Additional, relevant, and interesting exercises are suggested for students to explore that exercise math, reading, or science skills/comprehension that pushes beyond the grade level.
Teacher Development	Information in the instructional text, Know the Science boxes, and Know the Standards boxes is provided to support ongoing teacher development with regard to both content and the teaching process.
Monitor Progress	Opportunities for formative assessment appear throughout the instructional support. These instances are most consistently noted in a Check for Understanding that concludes each lesson segment.

The Core Lessons

- Lesson time: Each Core Lesson part constitutes one classroom session of thirty to forty-five minutes. Some activities and performance tasks will require setting aside a longer block of time.
- Lesson order: The lesson parts are coherently sequenced to build from one to the next, linking student engagement across lessons and helping students build new learning on prior knowledge.

Driving Question: What kinds of problems can we solve with computers?		
Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.		
Lesson and Part	**Title**	**Interaction Type and Learning Objective**
Lesson 1, Part 1	How Do Systems Help Solve Problems?	Student Reader Read Aloud: Chapter 1, "How Do Systems Help Solve Problems?" • Understand the basic concept of a system. • Recognize that all the components within a system need to function for the system to work properly.
Lesson 1, Part 2	What Is a System?	Classroom Interactive • Identify the component parts of a common object. • Describe how the different parts of a common object function to form a system.
Lesson 1, Part 3	How Can a Computer Problem Be Fixed?	Classroom Interactive • Use troubleshooting strategies to identify and solve simple hardware and software problems.
Lesson 2, Part 1	How Does Communicating Solve Problems?	Student Reader Read Aloud: Chapter 2, "How Does Communicating Solve Problems?" • Describe computer network uses for communication. • Identify the need to keep information secure.
Lesson 2, Part 2	How Does Information Travel Through a Network?	Classroom Interactive • Model how information is broken down into packets, transmitted, and then reassembled.
Lesson 2, Part 3	What Information About You Is Okay to Share Online?	Classroom Interactive • Recognize the risk of sharing private information online. • Differentiate between private and personal information.
Lesson 3, Part 1	How Does Collecting Data Solve Problems?	Student Reader Read Aloud: Chapter 3, "How Does Collecting Data Solve Problems?" • Define *data*. • Describe ways data can be collected.

Lesson 3, Part 2	What Tools Do We Use to Collect Data?	Classroom Interactive • Recognize different tools for collecting various types of data. • Differentiate information based on opinion from facts.
Lesson 3, Part 3	Collecting, Organizing, and Presenting Data	Classroom Interactive • Use visual representations to display data. • Draw conclusions about data from visual displays.
Lesson 4, Part 1	Solving Problems with Planning and Teamwork	Student Reader Read Aloud: Chapter 4, "Solving Problems with Planning and Teamwork" • Define *roles* and *collaboration*. • Recognize the importance and advantage of teamwork.
Lesson 4, Part 2	How Can People Work as a Team to Find a Solution?	Classroom Interactive • Work collaboratively to solve a design problem. • Use an iterative process to build a structure that meets specific criteria.
Lesson 5, Part 1	Data, Programmers, and Problem-Solving	Student Reader Read Aloud: Chapter 5, "Data, Programmers, and Problem-Solving" • Explain how algorithms provide instructions to a computer. • Define *variable*.
Lesson 5, Part 2	How Can a Problem Be Solved in Different Ways?	Classroom Interactive • Compare different ways to solve the same problem. • Recognize that different solutions exist for the same problem.
Lesson 5, Part 3	Variables and Data	Classroom Interactive • Model using variables to produce different outcomes.
Lesson 6, Part 1	Solving Problems with Codes	Student Reader Read Aloud: Chapter 6, "Solving Problems with Codes" • Break a process down into steps (decomposition). • Explain the coding concepts of sequences, events, and loops. • Describe grouped components of a system or program (modularity).
Lesson 6, Part 2	How Can a Task Be Broken Down into Steps?	Classroom Interactive • Decompose a process. • Describe how decomposition can make difficult problems easier to solve.

Lesson 6, Part 3	How Does a Computer Know to Perform a Specific Action?	Classroom Interactive • Recognize day-to-day examples of events, sequences, loops, and conditionals. • Develop a board game that includes events, sequences, loops, and conditionals.
Lesson 6, Part 4	How Can a Program Be Modified to Do Something Different?	Classroom Interactive • Modify a sequence to steps to produce an altered outcome.
Lesson 7, Part 1	Testing Programs	Student Reader Read Aloud: Chapter 7, "Testing Programs" • Explain the need to test designs and systems.
Lesson 7, Part 2	How Can You Debug a Program?	Classroom Interactive • Evaluate step-by-step directions to accomplish a task. • Identify and fix simple bugs in an algorithm.
Lesson 8, Part 1	Making Programs Usable	Student Reader Read Aloud: Chapter 8, "Making Programs Usable" • Describe factors that affect the usability of computer devices and applications.
Lesson 8, Part 2	Responsible Programming	Classroom Interactive • Explain how credit (or attribution) and copyright apply to creative work. • Recognize the rights and responsibilities of a creator.
Lesson 8, Part 3	Making Apps Usable for the Most People	Classroom Interactive • Improve the accessibility of a design.
Lesson 9, Part 1	Computer Technology over Time	Student Reader Read Aloud: Chapter 9, "Computer Technology over Time" • Identify ways in which technology has changed over time.
Lesson 9, Part 2	Computers and How We Live	Classroom Interactive • Create and interpret a timeline. • Recognize that current computing technology has increased the amount and speed of information that can be accessed and/or shared.

Lesson 10, Part 1	Computer Technology Solves Problems	Student Reader Read Aloud: Chapter 10, "Computer Technology Solves Problems" • Recognize both the positive and negative impacts of technology on society.
Lesson 10, Part 2	Explaining a Design	Classroom Interactive • Explain and elaborate on choices made in a design process.

Activity Pages

Activity Pages

AP 2.2

Black line reproducible masters for Activity Pages are included in Teacher Resources at the back of the Teacher Guide. The icon shown to the left appears throughout the Teacher Guide wherever Activity Pages (AP) are referenced.

Make sufficient copies for your students in advance of each lesson.

Lesson 2, Part 2—Message Data Packets (AP 2.2)

Online Resources for Science

Online Resources

For each unit, the Teacher Guide includes references to online resources (including external websites and downloadable documents) to enhance classroom instruction. Look for the icon on the left.

Use this link to download the CKSci Online Resources for this unit:

www.coreknowledge.org/cksci-online-resources

The Online Resources Guide also links to lists of additional recommended children's books that support the content of this unit.

Teaching Strategies

Start with the familiar.

Lead with an experience. Begin each lesson with a demonstration, activity, or question about a phenomenon to engage students and focus their attention on the topic. Start with the familiar. Every science topic introduced to students relates in some way to their known world and everyday experiences. The purpose of every lesson is to build a bridge between what is familiar to students and a broader knowledge about the way the world works.

Ask driving questions.

Each multipart lesson is built around a lesson Driving Question. And at the beginning of each Teacher Guide lesson segment, you will find a reminder of the Overarching Unit Objective. Each lesson activity provides an incremental concept to help students move toward the objective and ultimately be able to offer a confident answer to the Driving Question. Pose discussion questions in each class session with the Driving Question and Overarching Unit Objective in mind.

Encourage scientific thinking.	Approach the lessons with students not as learning about computer science, but as learning about the world with a scientific mind. Throughout the lessons, encourage students to ask questions about what they observe, do, and read. Record relevant questions in a prominent place in the classroom. Guide students back to these questions as opportunities to answer them emerge from readings, demonstrations, and activities.
Use continuous Core Vocabulary instruction.	During instruction, emphasize Core Vocabulary terms and their meanings in context rather than relying on isolated drill for memorization of definitions. Through scaffolded questioning, encourage students to come up with definitions in their own words and to use the words in their own sentences. Core Vocabulary words for each lesson, as well as Language of Instruction, other key terms teachers are encouraged to use in discussing topics with students, are provided at the start of each lesson. You can find Core Vocabulary and selected Language of Instruction definitions in the Glossary at the back of this Teacher Guide.
Emphasize observation and experience.	Lessons employ various ways for students to learn, including watching, listening, reading, doing, discussing, and writing.
Make frequent connections.	Use a combination of demonstrations and reading materials, rich with examples, to help students recognize how the concepts they are learning apply in their everyday lives. Prompt students to relate lesson content to their own experiences, to relate the new and unfamiliar to the familiar, and to connect ideas and examples across disciplines.
Monitor student progress.	Use verbal questioning, student work, and the Check for Understanding prompts at the end of each lesson part to monitor progress during each lesson and to measure understanding at the conclusion of the unit. Many lessons provide tips to help you support students who need further explanations or clarifications.

Effective and Safe Classroom and Online Activities

Conducting safe classroom demonstrations and activities and safe online interactions is essential to successful elementary education. The following resources, included at the back of the Teacher Guide, provide Core Knowledge's recommendations for developing effective science and computer science classroom activities:

- Internet Safety
- Student Online Safety Contract
- Strategies for Acquiring Materials

Online Resources

These resources may also be accessed within the CKSci Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Materials and Equipment

The unit requires a variety of materials to support various ways of learning (including doing, discussing, listening, watching, reading, and writing). Prepare in advance by collecting the materials and equipment needed for all of the demonstrations and hands-on investigations.

- A large whiteboard, blank sheets of printer paper, student notebooks, pencils, and scissors are routinely required but not listed below.
- A classroom computer, tablet, or other computing device, as needed for discussion, is referred to in the materials for lesson segments in which it is used but is not repeated in the materials listed here. Internet access and the means to project images/videos for whole-class viewing are also required in many lesson segments but not repeated below.

Lesson 1, Part 2

- retractable ballpoint pens (1 per pair)
- large sheet of butcher paper (1 sheet per pair)
- glue dots (1 set per pair)
- glue gun (per instructor, optional)
- markers or colored pencils (assortment per pair)
- safety goggles (1 per student)
- tweezers (1 per pair, optional)

Lesson 1, Part 3

- labeled 5" x 8" lined index cards (1 per small group)
- pieces of small paper (several pieces per small group)
- fine-tip markers of different colors
- computer or laptop

Lesson 2, Part 2

- 3 envelopes (for demonstration)

Lesson 2, Part 3

- individual whiteboard or chalkboard (one per group)
- whiteboard markers or chalk
- computer with internet access
- large TV monitor or projector with display cables (such as HDMI, USB-C, or DisplayPort).

Lesson 3, Part 2

- tablet or other writing device (per group)
- different data-collection tools, such as digital thermometer, stopwatch, camera, scale, survey, online attendance book, etc. (one tool per group)
- computer with internet access for group research (optional)

Lesson 3, Part 3

- tablet or laptop with spreadsheet and graphing software (1 per group)
- tool reports from Lesson 3.2
- whiteboard or anchor chart with responses from Lesson 3.2
- examples of different types of graphs for display
- computer with school email for electronic submission of surveys

Lesson 4, Part 1

- two or three large blankets, sheets, or tablecloths

Lesson 4, Part 2

- building elements, such as foam beads and chenille sticks, marshmallows and lollipop sticks, gumdrops and toothpicks (about 30 pieces of each per group)
- tape (about 10 pieces per group)
- ruler or measuring tape for checking height (1 per group)
- book for testing strength (1 per group)
- stopwatch or timer with second counter (1 per group)
- digital camera or phone camera

Lesson 5, Part 1

- three or four buckets (support)

Lesson 5, Part 2

- chalk or painter's tape
- measuring tape
- stopwatch or timer

Lesson 5, Part 3

- index cards (3 per student)
- 3 boxes or bins to hold index cards

Lesson 6, Part 1

- dot matrix enlargement, or one found online to be displayed
- access to marching band drill charts for extension activities

Lesson 6, Part 3

- game construction materials: board materials (such as poster board, cardboard boxes, and/or file folders), construction paper, scrapbook paper, stickers, index cards, crayons, markers, colored pencils, scissors, glue sticks, tape, game pieces (such as water bottle caps, mini erasers, and/or small manipulatives), spinners and/or dice (whole class)
- storage boxes or bins for completed games
- several common board games for demonstration

Lesson 6, Part 4

- game designs from Lesson 6.3

Lesson 7, Part 1

- access to blocks for the extension activity
- access to online resources for simple student debugging activities for the extension activity

Lesson 7, Part 2

- jar of peanut butter, initially closed (Note: if any students have a peanut allergy, you can substitute an unopened package of softened cream cheese for the peanut butter.)
- jar of jelly or jam, initially closed
- bag of sliced bread, initially closed
- paper plate
- knife
- paper towels

Lesson 8, Part 1

- two printed or online photos, one showing a person dressed in a fancy outfit and the other in a typical summer outfit

Lesson 8, Part 2

- computer or tablet with internet access and web browser (per group)

Lesson 8, Part 3

- teacher-created character cards representing diverse disabilities (1 per group)

Lesson 9, Part 2

- butcher paper or construction paper to assemble collage (piece per group)
- old magazines and/or access to printer for printing images
- yardstick (1 per group)
- ruler (1 per group)
- glue sticks (1 per group)
- markers (per group)
- computer with internet access
- large TV monitor or projector with display cables (such as HDMI, USB-C, or DisplayPort).

Lesson 10, Part 2

- game design projects from Lessons 6.3 and 6.4
- sticky notes

Problem-Solving and Computers Pacing

_____'s Class

Note to Teacher: *Problem-Solving and Computers* can be taught on consecutive days as a supplemental unit to your science or math curriculum. It can also be offered as an enrichment program. If the program is implemented in consecutive thirty- to forty-five-minute class sessions, it will take twenty-seven days to complete.

Week 1

Day 1	Day 2	Day 3	Day 4	Day 5

Week 2

Day 6	Day 7	Day 8	Day 9	Day 10

Week 3

Day 11	Day 12	Day 13	Day 14	Day 15

Week 4

Day 16	Day 17	Day 18	Day 19	Day 20

Week 5

Day 21	Day 22	Day 23	Day 24	Day 25

Week 6

Day 26	Day 27	Day 28	Day 29	Day 30

LESSON 1, PART 1

How Do Systems Help Solve Problems?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Understand the basic concept of a system.
- ✓ Recognize that all the components within a system need to function for the system to work properly.

Instructional Activities

- student reading
- whole-class discussion

CSTA Standards

Concept: Computing Systems

Subconcepts and Standards:

- **Devices: 1B-CS-01** Describe how internal and external parts of computing devices function to form a system. (P7.2)
- **Hardware and Software: 1B-CS-02** Model how computer hardware and software work together as a system to accomplish tasks. (P4.4)
- **Troubleshooting: 1B-CS-03** Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies. (P6.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

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troubleshoot

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

cause **effect** **system**

Instructional Resources

Student Reader

Ch. 1

Student Reader, Chapter 1
How Do Systems Help Solve Problems?

Materials and Equipment

Collect or prepare the following:

- internet access
- means to project images for whole-class viewing

The Core Lesson

1. Focus attention on today's topic.

Systems have been a part of our world for centuries. Historically, people created systems to help make their lives easier. In fact, that still holds true today. You may prompt students with some general examples of electricity or transportation. Or you may be more specific by asking students to think about systems in their own homes or at school. Ask students to think more deeply about their examples. Ask: "Do you ever wonder how those systems work? Would anyone like to explain how they think a particular system works?"

2. Read and discuss "How Do Systems Help Solve Problems?"

Student Reader

Ch. 1

Read together or have students read independently "How Do Systems Help Solve Problems?", in the Student Reader. The selection introduces the idea that systems are more common than students might realize. The text introduces the concept that doorknobs and even pens are systems.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 2

What systems have you used today?

» Student responses will vary but may include the water fountain, a computer, a tablet, a phone, and so on.

What is a visible (or external) part of a doorknob system?

» The part you move with your hand

Page 3

What does the word *complex* mean?

» Define the term *complex* as having parts that go together in complicated ways.

Can you think of any examples or experiences you may have had when you knew that a system wasn't working correctly? And what effect did it have on the situation?

» Student responses will vary, but you may point out that one example is when a traffic light is not working Unless a policeman is there to direct traffic, when there are no regular signals coming from the traffic lights, the traffic may not be able to flow as easily through an intersection. This might cause confusion and become a dangerous situation.

Page 5

Can you think of one purpose for a computer?

» Students may share that a computer is used for entertainment, social media, creating videos, storing photos, or doing work.

3. Check for understanding.

Ask students to think about systems one more time and to name a system they have used. Ask them to think about how the system works. Reread the question: "Is one purpose more important than another purpose?" Tell students to think about this question for a moment as you explain that, throughout this lesson, they learned about systems. Now, ask students to form an opinion based on the question. Then ask them to turn and talk with a partner or write a short journal response defending their opinion using the information they have learned from the text.

Unplugged Activity

SUPPORT—For students who might not recognize that not all systems are a type of advanced technology, have them go on an exploration around the room to try and understand how various systems might work. For example, ask them to open a cabinet, turn the lights off and on, open a window, and/or use a sink for which the pipes are visible. Ask them to list what they find. Then ask them to write or tell about how that particular system works.

Device-Based Activity

CHALLENGE—For students who want to learn more about systems and why they exist, have them think about and research how long systems have been in place. Many systems have been in use for thousands of years (which may also help students recognize that systems don't need to be advanced). Explore the concept of an aqueduct with them. Research the Roman aqueducts in particular, and discuss the purposes and usefulness of these aqueducts during that time period.

Device-Based Activity

EXTEND—For students who show an avid interest in systems, have them research how a current computer part works today versus how a similar part worked in the past, such as a computer keyboard and a typewriter. Have them create a slideshow or other form of presentation to share their learning.

ALERT—A common misconception about systems is that they need to be complicated. Actually, a system can be as simple as pulling a string and ringing a bell. Generally speaking, systems are put in place to make things easier.

LESSON 1, PART 2

What Is a System?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Identify the component parts of a common object.
- ✓ Describe how the different parts of a common object function to form a system.

Instructional Activities

- student investigation
- whole-class discussion

CSTA Standards

Concept: Computing Systems

Subconcepts and Standards:

- **Devices: 1B-CS-01** Describe how internal and external parts of computing devices function to form a system. (P7.2)
- **Hardward and Software: 1B-CS-02** Model how computer hardware and software work together as a system to accomplish tasks. (P4.4)

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component **external** **internal** **system**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

ballpoint	**barrel**	**clicker**	**clip**
retractable	**spring**	**tip**	

Materials and Equipment

Collect or prepare the following:

- retractable ballpoint pens (1 per pair)
- sheet of paper (1 per pair)
- large sheet of butcher paper (1 sheet per pair)
- glue dots (1 set per pair)
- glue gun (per instructor, optional)
- markers or colored pencils (assortment per pair)
- safety goggles (1 per student)
- tweezers (1 per pair, optional)
- large whiteboard or anchor chart

Advance Preparation

- Obtain a supply of retractable, ballpoint, click pens that twist or unscrew into separate barrels. Note that these pens will not be reassembled, so inexpensive bulk pens will work. You may wish to have a few spares on hand in case students have difficulty taking a pen apart or perhaps lose one of the pieces.
- Cut the butcher paper so there is one piece per pair of students. Put each piece of butcher paper on a desk or table.
- This activity involves taking apart pens and then gluing the separate pieces onto butcher paper. The recommended method for this is to use glue dots. However, if glue dots are not available, you can use a glue gun instead.
- Students do not need to use tweezers for the investigation. However, some of the internal pieces of the pen are small. Some students may do better handling these smaller parts with tweezers instead of with their fingers.

The Core Lesson

1. Focus attention on today's topic.

Place students in pairs. Distribute a ballpoint pen and a sheet of paper to each pair of students. Tell the students to look at the pen. Explain to students that many people write with ballpoint pens. Have students experiment writing with (testing) the pen on a sheet of paper. Then ask students how they think this device works. Record responses on the whiteboard or anchor chart.

Explain that a ballpoint pen has many parts, all of which work together as a system. Point out that some of the parts are external parts. These are the parts we can see, such as the barrel and the clicker button. Other parts are internal parts. We can't see these internal parts unless we take the pen apart. (See Know the Science.)

2. Facilitate the activity.

Unplugged Activity

Tell students that today they are going to explore the external and internal components, or parts, of a ballpoint pen system. Distribute the safety glasses, assorted markers/colored pencils, glue dots, and tweezers (if they are being used).

ALERT—Students must wear goggles when taking the pens apart, because ballpoint pen ink can cause eye Irritation. If a student does get ink in their eye, they should rinse the irritated eye with cool water until the discomfort is gone. Students should also be cautioned not to taste the ink.

Have students place their pens on top of the butcher paper. Invite them to observe the pens closely, identifying the external parts. Encourage them to name the parts by describing them. For example, some students may name the barrel the "holder." Students should write their initial observations about the pens on the butcher paper.

Next, ask students to carefully disassemble their pens. They should not try to take the ink tube apart. Let students know they can handle the small parts with tweezers to better observe the parts.

Encourage students to use glue dots to attach each part to the butcher paper, leaving space in between the pieces for writing. Then ask them to label each part on the butcher paper. Then have them describe the role each part plays in the working ballpoint pen system. Help students identify the parts if they do not recognize them.

3. Check for understanding.

Unplugged Activity

Display the completed pen dissection papers. Point out the different parts. For each part, **ask**: "How do you think this particular part helps the pen do its job?" After discussing each of the parts, return to the students' original responses on the whiteboard or anchor chart. Encourage students to suggest changes to their responses on the list based on what they've learned about the pen components. Ask students if the pen system would still be able to do its job if one of the parts were missing and why.

EXTEND—Distribute a second pen to each pair of students and encourage them to explore possible ways to make the pen work or not work by removing different parts.

Know the Science

Online Resources

Retractable Ballpoint Pen Components The main external components of a retractable ballpoint pen include the barrel, the clicker button, the nose cone, a pocket clip, and in some cases, a grip. The main internal components include the spring, the ball tip, a socket (which keeps the ball tip in place), the ink chamber (usually a plastic tube), and the clicker button assembly, known as the "cam." See the Online Resource Guide for links to more information on how the various parts work.

www.coreknowledge.org/cksci-online-resources

LESSON 1, PART 3

How Can a Computer Problem Be Fixed?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Use troubleshooting strategies to identify and solve simple hardware and software problems.

Instructional Activities

- teacher demonstration
- student investigation
- whole-class discussion

CSTA Standards

Concept: Computing Systems

Subconcept and Standard: Troubleshooting: 1B-CS-03 Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies. (P6.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

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trial and error **troubleshooting**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

identify **strategy** **system**

Materials and Equipment

Collect or prepare the following:

- labeled 5" x 8" lined index cards (1 per small group)
- pieces of small paper (several pieces per small group)
- fine-tip markers of different colors
- pencils or pens
- large whiteboard or anchor chart
- computer or laptop

Advance Preparation

- Label the top of each index card with a different simple hardware or software problem. Possible problems include the following:
  - A website isn't loading.
  - The mouse doesn't work.
  - The keyboard isn't working.
  - There is no sound.
  - The volume is too loud.
  - The program or screen froze.
  - My program/internet window disappeared.
  - I can't enter my login.
  - The printer isn't printing.
- Before class, unplug the computer or shut down the laptop, and place it a central location in the classroom.

The Core Lesson

1. Focus attention on today's topic.

Once students are settled in the classroom, direct their attention to the computer or laptop. Explain that your computer screen is black and you are not sure how to fix the problem! Allow students to walk up and observe the computer. Then tell the students that you would like their help troubleshooting the problem. Explain that troubleshooting is a step-by-step approach to solving a problem.

Tell students that the first step in troubleshooting is to identify the problem. On the whiteboard or anchor chart, write the heading "Troubleshooting." Below the heading, write "1. Define the problem." Ask students how the computer problem can be described. Record responses on the whiteboard or anchor chart.

The next step is to try to identify the possible causes of the problem. On the board, write "2. Identify possible causes." Explain to students that this step involves asking questions and looking for clues. For example, is the device plugged in or charged? Is a monitor turned on? Does a printer have paper or toner? Are there any warning lights or error messages? Ask students to provide some other causes. Record responses on the board.

The third step is to take action. Write "3. Take action." on the whiteboard. Explain that for this step, people use trial and error. In other words, they try different possible solutions to the problem. Tell students that there are some common tricks for solving hardware problems, such as checking that the cables and power cords are plugged in, making sure the device is turned on, restarting, looking to see if the volume or screen brightness is turned up (or turned down). Some methods for solving software problems are closing out of a program and reopening it, restarting

the device, closing out of tabs and programs you aren't using, using a different browser, clicking on the minimize/maximize button, making sure the caps lock key is turned off, and checking that you are entering a login correctly. Ask students what might be the first thing to do to try to fix this computer.

Record responses on the whiteboard. Then demonstrate testing each potential solution the students have suggested. Circle the correct solution after you have successfully fixed the problem. (Plugging in the device and/or turning the machine on.)

2. Facilitate the activity.

Unplugged Activity

Tell students that today they are going to work together to create a set of classroom troubleshooting tips. Place the students in small groups of three to five students, and distribute a labeled index card, the pieces of paper, fine-tip markers, and pencils or pens.

Explain that the label on the index card defines a particular technology problem. Ask the students to brainstorm possible causes of their assigned problem, recording their answers on the pieces paper. Then ask them to take their index cards and make a list of several possible things to try to solve the problem. Encourage students to use a different colored marker for each different possible solution.

> **SUPPORT**—If students have difficulty identifying possible causes or possible solutions, guide them to consider whether the problem is more likely a hardware problem or a software problem. Then, ask students to think about some ways people might try fixing a hardware problem versus a software problem. Encourage students to consider things they might have tried at home or at school when encountering a similar problem.

3. Check for understanding.

Unplugged Activity

Ask each group to present their problem. Then have the group read their troubleshooting tips. Ask students to explain why it is important to identify the problem before trying possible solutions. Then ask them the benefit of using trial and error to test solutions.

Know the Standards

1. 1B-CS-03 Troubleshooting Although computing systems vary, common troubleshooting strategies can be used across many different systems. Students should use troubleshooting strategies to identify problems that could include an unresponsive device, a power supply issue, a broken network connection, an app crashing, a device not playing sounds, or an attempted login not working. Solutions may include rebooting the device, checking for power, checking network availability, quitting and then relaunching an app, making sure speakers are turned on or headphones are plugged in, and making sure that the caps lock key is not on. Because computing devices are composed of an interconnected system of hardware and software, troubleshooting strategies need to address both.

LESSON 2, PART 1

How Does Communicating Solve Problems?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Describe computer network uses for communication.
- ✓ Identify the need to keep information secure.

Instructional Activities

- student-reader
- whole-class discussion

CSTA Standards

Concept: Networks and the Internet

Subconcepts and Standards:

- **Network Communication and Organization: 1B-NI-04** Model how information is broken down into smaller pieces, transmitted as packets through multiple devices over networks and the Internet, and reassembled at the destination. (P4.4)
- **Cybersecurity: 1B-NI-05** Discuss real-world cybersecurity problems and how personal information can be protected. (P3.1)

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communicate **network** **private** **public**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

information **packet**

Instructional Resources

Student Reader

Ch. 2

Student Reader, Chapter 2
How Does Communicating Solve Problems?

Materials and Equipment

Collect or prepare the following:

- internet access and the means to project images/video for whole-class viewing
- chart paper

The Core Lesson

1. Focus attention on today's topic.

Ask students what they think of when they hear the word *communicate*. Listen to their thoughts, and guide them as necessary. Tell students that communication is a way of sharing thoughts and ideas with other people but that it isn't just people that communicate. Ask students if they can think of anything else that communicates. They may mention animals. Ask them to stretch their minds further and think about how a computer communicates. Then ask students to think about how a computer might communicate in different ways in the future.

2. Read and discuss "How Does Communicating Solve Problems?"

Student Reader

Ch. 2

Read together or have students read independently "How Does Communicating Solve Problems?", in the Student Reader. The selection presents the idea that communication occurs in a variety of ways throughout everyday life, and that different types of communication can look very different from one another.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 6–7

What is one way that Lin communicates with Click?

» Answers may include that Lin puts the ball in the basket when he wants to stop playing, makes a hand motion for Click to sit, or calls the name "Click" when he wants him to come.

Do you think that Click just knew what the commands from Lin were? Why or why not?

» No, Click did not just know them. Lin had to teach Click and give Click the information in order for him to learn these commands.

Pages 8–9 **What do you think is private information versus public information?**

» Private information includes passwords but can also include your personal information like your address, birthday, family members, pictures or school name.

When do you think it is okay to share private information?

» Private information is private for a reason, but you may consider sharing the information with your parents or guardian and other trusted adults who can help you with troubleshooting a problem.

3. Check for understanding.

Unplugged Activity

Tell students they have learned some of the ways computers communicate and they also have begun to learn a little bit about private and public information. On the whiteboard or anchor chart, have students make a list of things that should be kept private while working with computer devices and some things that are okay to be public.

SUPPORT—For students that might not be able to name private and public information, provide a list of both private and public information. Have students draw a line through the private information and circle the public information.

CHALLENGE—For students who are interested, explain that there are two different networks that computers can communicate through. One type of network is called a local area network. These networks are more familiar, as they are based locally and connect a small number of computers. The school or library computer lab is an example of this. The other type of network is a wide area network, which is often used to expand the local network. The network used by a company that has expanded its offices to other cities or countries may be an example of this.

Know the Science

In this chapter, communication between computers is compared to how humans communicate with animals. Computers use connections to communicate with other computers via networks, including the internet. Once computers are connected with one another by means of a network, they are able to use the same hardware (like printers) or software (like programs) and transmit data. See the Online Resource Guide for a link to an explainer to support your own understanding.

www.coreknowledge.org/cksci-online-resources

LESSON 2, PART 2

How Does Information Travel Through a Network?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Model how information is broken down into packets, transmitted, and then reassembled.

Instructional Activities

- whole-class activity
- whole-class discussion

CSTA Standards

Concept: Networks and the Internet

Subconcept and Standard: **Network Communication and Organization: 1B-NI-04** Model how information is broken down into smaller pieces, transmitted as packets through multiple devices over networks and the Internet, and reassembled at the destination. (P4.4)

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data **header** **IP Address** **packet**

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internet **IP (Internet Protocol)** **network** **server**

Materials and Equipment

Collect or prepare the following:

- scissors (pair per group)
- pens or pencils (1 per group)
- sheets of printer paper (2 per group)
- 3 envelopes (for demonstration)
- large whiteboard or anchor chart

Activity Page

AP 2.2

Activity Page 2.2 Message Data Packets (AP 3.2)

Advance Preparation

- Make sufficient copies of AP 2.2 for each small group.
- Before class, write a three-line message on a sheet of paper, with each line consisting of no more than eight characters, such as

  (line 1) Hi, this
  (line 2) note is
  (line 3) from me!

- On each envelope, write the same fictitious sender address, along with a return address.

The Core Lesson

1. Focus attention on today's topic.

Ask students to indicate by a show of hands if they've ever sent or received a letter or a package. Point out that to send mail to someone who is somewhere else, you need their mailing address to make sure it's delivered to the right person. Show students one of the envelopes you prepared. Point out the mailing address and the return address. Ask students the address of where the envelope is going. Then ask the address of where the envelope is being sent from.

Explain that every time you access a website, send a message, or watch a video online, data is sent and received over the internet. Tell students that each computer has its own IP address. Each IP address is a combination of numbers rather than names.

Next, explain to students that data on the internet is not sent as a single long message. Instead, the data is broken into smaller chunks of data called packets. Each packet is sent through the internet. When all the packets arrive at their destination, they are reassembled.

Demonstrate how this works using the pre-written message and the envelopes. Show students the three-line message. Then cut each line apart. Point out that now the message is in pieces and that we need to indicate the order of the pieces and how many pieces there are so that the message can be put together again in the right way. On one envelope, write "1 of 3," and place the first line of the message inside. On the second envelope, write "2 of 3," and place the second line of the message inside. Finally, on the third envelope, write "3 of 3," and place the last line of the message inside.

Explain that there are two main parts of a packet. The first part is the portion of a message that shows the IP address.The second part is the individual number of of the packet, which is called a header. This is like an envelope for a letter. The rest of the message is the data, which is like the letter inside the envelope.

2. Facilitate the activity.

Activity Page

AP 2.2

Assign students into small groups. Make sure there is an even number of groups. Distribute the activity pages, scissors, writing implements, and paper. Tell students that they are going to try to send messages in packets across the classroom to another group. Assign each group a three-digit "IP address," and then pair groups up.

Ask each group to work together to create a message to send to another group. Then ask them to copy the message onto the different packets on the activity page. Point out that each packet cannot contain more than eight characters, including any spaces or punctuation. Have students fill in the packet number and total number of packets in the header for each packet. Then ask them to cut apart the page to separate each packet.

Unplugged Activity

Invite one or two students in each group to be the message carriers and another student to be the receiving server. Ask the message carriers to take the packets one at a time over to the appropriate group's receiving server. Once all the packets have been delivered, have the receiving group put the packets in order and copy the message onto a sheet of paper.

3. Check for understanding.

Unplugged Activity

Have groups compare their original message with the reconstructed message. Discuss the process of sending and receiving messages as packets with the class. Ask students why they think IP addresses are used for both the sending and the receiving devices. (This is so that the sending device knows where to send the message and the receiving device knows where to reply.) Then ask why they think it's important to number the packets. (The numbers tell the receiving computer the total number of packets it should expect to receive and the order of the packets.)

EXTEND—Explain to students that everything that is transferred through the internet is transferred in packets, including audio, video, and images. Have students repeat the activity, this time using a paper copy of an image, such as Earth from space. Students should cut the page into a predetermined number of packets (number of pieces) and then send the packets one at a time to another student in the classroom, who will reassemble the image.

LESSON 2, PART 3

What Information About You Is Okay to Share Online?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Recognize risk of sharing private information online.
- ✓ Differentiate between private and personal information.

Instructional Activities

- whole-class activity
- whole-class discussion

CSTA Standards

Concept: Networks and the Internet

Subconcept and Standard: Cybersecurity: 1B-NI-05 Discuss real-world cybersecurity problems and how personal information can be protected. (P3.1)

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identify thief **personal information** **private information**

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identity **internet** **online** **unique**

Materials and Equipment

Collect or prepare the following:

- individual whiteboard or chalkboard (one per group)
- whiteboard markers or chalk
- computer with internet access
- large TV monitor or projector with display cables (such as HDMI, USB-C, or DisplayPort)
- large whiteboard or anchor chart

Advance Preparation

- Set up the computer and second monitor or projector so that the computer desktop is duplicated (mirrored) on the second screen.
- Cue up the link to the Private and Personal Information video. (Note: This video is also available in Spanish and with subtitles.)
- On the whiteboard or anchor chart, draw a two-column chart. Label one column "Private" and the other column "Personal."

The Core Lesson

1. Focus attention on today's topic.

Children at the age of elementary students should not interact on the internet without adult guidance and supervision and should not have social media accounts. However, there are many good and appropriate learning resources for children to use with adult supervision. Even sites that are highly appropriate can pose a risk for predators to manipulate communication to extract private and personally information from young people. Use the discussion points in this lesson to emphasize that it is not safe to trust anyone they do not personally know (who is also known by their guardians) with any information about them at all.

Introduce the lesson question to students. Explain that some information is safe to share on the internet but that some information is not. Information that can't be used to identify you, such as your age, how many siblings you have, and your favorite food, is called personal information and is usually safe to share. Information that can be used to identify you, such as your street address, email, and phone number, is called private information and is not safe to share on the internet. Tell them that they are going to watch a video that explores what type of information is and is not okay to share online.

Online Resources

Show the Private and Personal Information video. See the Online Resources Guide for a link to the video.

www.coreknowledge.org/cksci-online-resources

After viewing the video, explain that some people will actively try to get you to share private information so that they can use it to take over your identity. These people are called identity thieves. After someone has taken someone else's identity, an identity thief can use that person's name to get a driver's license or buy things or commit a crime, even if the person whose identity they stole isn't old enough to do these things! Remind students that they should not give any information and that they should their teacher, parent, or guardian know if any website or person online asks for their private or personal information, or if someone asks them to share pictures of themselves or to do or say or watch anything that makes them feel uncomfortable.

2. Facilitate the activity.

Unplugged Activity

Place the students into small groups, and distribute an individual whiteboard or chalkboard, along with a whiteboard marker or chalk, to each group. Tell students that the class is now going to play a game and that each group is a team. Give each team a letter or number name (e.g., Team A or Team 1).

Next, explain the rules of the game. Tell students you will name a type of information and then the teammates should work together to decide if the information is personal or private. The group should write their answer on their board and then turn the board over when they are done. After all the teams have recorded their responses, they should flip the boards over to show their answers at the same time. Each team with the correct response will get a point. The winners are the team(s) with the most points at the end of the game!

Read the following types of information, one at a time. (Do not read the answers)

- First name or nickname (personal)
- Full name—first, last, and middle names (private)
- Favorite song (personal)
- Eye color (personal)
- Date of birth (private)
- Credit card information (private)
- Number of brothers and sisters (personal)
- Age (personal)
- Home address (private)
- Name of school (private)
- Phone number (private)
- Email (private)

After each type of information, ask teams to consider whether this is information that could be true of many other people (personal information) or whether it is information that can be used to identify you because it is unique to you (private information). After teams have flipped their boards over, record the correct answer on the whiteboard or anchor chart. After students have responded to all twelve types of information, have them tally up how many they responded to correctly. Name the team or teams with the most points.

(Adapted from https://www.commonsense.org/education/digital-citizenship/lesson/private-and-personal-information)

3. Check for understanding.

Have students imagine that there is a new student attending class virtually online today. Ask the students what personal information they would share with the student and which private information they would not share with the student. Next, have students imagine that they are joining a new social media group. Would they still share the same information? Why or why not? Hold a discussion with students about the differences in regulation between an academic class online and a social media website. Encourage students to refrain from sharing any information, private or personal, on social media with people they do not know personally.

LESSON 3, PART 1

How Does Collecting Data Solve Problems?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Define *data*.
- ✓ Describe ways data can be collected.

Instructional Activities

- student reading
- whole-class discussion

CSTA Standards

Concept: Data Analysis

Subconcepts and Standards:

- **Storage: 1A-DA-05** Store, copy, search, retrieve, modify and delete information using a computing device and define the information stored as data. (P4.2)
- **Collection, Visualization, and Transformation: 1B-DA-06** Organize and present collected data visually to highlight relationships and support a claim. (P7.1)
- **Inference and Models: 1B-DA-07** Use data to highlight or propose cause and-effect relationships, predict outcomes, or communicate an idea. (P7.1)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

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data

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

cube **data table**

Instructional Resource

Student Reader

Ch. 3

Student Reader, Chapter 3
How Does Collecting Data Solve Problems?

Materials and Equipment

Collect or prepare the following:

- internet access and the means to project images/video for whole-class viewing

The Core Lesson

1. Focus attention on today's topic.

Using chart paper or a computer to record student responses, ask the following questions:

- Raise your hand if you like ice cream.
- Raise your hand if you like brussels sprouts.
- Raise your hand if you like honeydew melon.
- Raise your hand if you like hot dogs.
- Record student responses by creating a graph to show students that you collected some information on things that they like.

Have students think about the ways they collect information about peers or people around them and then store that information in their minds for the future. Connect to the idea that computers store information in similar ways.

2. Read and discuss "How Does Collecting Data Solve Problems?"

Student Reader

Ch. 3

Read together or have students read independently "How Does Collecting Data Solve Problems?" in the Student Reader. The selection introduces the idea that there are a variety of ways and instruments to use to collect facts and information, also known as data.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 10

Look at the tools in the picture. What data do you think they were used to collect?

» Computers can be used for surveys and to write answers to questions. Thermometers take temperatures, scales measure mass or weight, and cameras record images.

Page 11

Say the following statements, and have the students identify which are facts and which are opinions.

a) The beach is the best place to go on vacation.

b) The ocean is made up of salt water.

c) The sun rises in the east.

d) Sunsets are more beautiful than sunrises.

» a) Opinion; b) Fact; c) Fact; d) Opinion

Page 12

What is a claim?

» A claim is a statement you think is true.

Ask students to make a claim based on the following question: will the ice melt faster as a sphere or as a cube?

» Record student responses on the board.

Page 13

Where does Lin collect and store his data?

» the computer

Why do you think using a computer makes collecting data easier?

» Student answers may vary. Computers can keep data organized, and data can easily be shared with others.

3. Check for understanding.

Unplugged Activity

Have students pair up and prepare a speech on the ways Lin used computers or other technology to store the data from his experiment. In the speech, ask students to make a claim on whether Lin used the best tools, in their opinion, for storing the data. Have students share their speeches either in written or oral form.

SUPPORT—For students who might not see a difference between a claim and a hypothesis, explain that a claim is based solely on the results of an experiment (or the evidence), whereas a hypothesis needs research and is a prediction of what could happen and is often followed by research.

EXTEND—As an extension activity, you may have students conduct Lin's melting ice experiment. Students can make a claim and then use tools to collect the data.

LESSON 3, PART 2

What Tools Do We Use to Collect Data?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Recognize that different tools for collecting various types of data.
- ✓ Differentiate information based on opinion from facts.

Instructional Activities

- student investigation
- whole-class discussion

CSTA Standards

Concept: Data Analysis

Subconcepts and Standards:

- **Collection, Visualization, and Transformation: 1B-DA-06** Organize and present collected data visually to highlight relationships and support a claim. (P7.1)
- **Storage: 1A-DA-05** Store, copy, search, retrieve, modify, and delete information using a computing device and define the information stored as data. (P4.2)

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data

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organize **present** **represent** **visualize**

Materials and Equipment

Collect or prepare the following:

- tablet or other writing device (one per group)
- different data-collection tools, such as a digital thermometer, stopwatch, camera, scale, survey, online attendance book, etc. (one tool per group)
- computer with internet access for group research (optional)
- large whiteboard or anchor chart

Advance Preparation

- Obtain five or six different types of tools used to collect data. These could be different types of analog tools (ie. pens, pncils, chalk, paper, books), digital tools (ie. CDs, DVDs, computers, digital clocks or watches), or online tools such as apps or word processing and spreadsheet programs. Each group should have different tools.

The Core Lesson

1. Focus attention on today's topic.

Remind students that data are the facts and information collected for reference or review. For example, a school will collect data on how many students are enrolled in a particular grade to determine how many teachers and classrooms they will need.

Tell students that the tools used to collect, organize, and present data visually are chosen based on the types of measurement they use as well as the type of data people wish to observe. (See **Know the Science.**) Present the following situation. Suppose I want to measure the height of a book in centimeters. What kind of tool should I use? (a centimeter ruler) Now suppose I want to measure the height of this room in feet. What kind of tool should I use? (a measuring tape or a yardstick)

Know the Science

Data Collection Tools There is a wide array of digital and analog data collection tools. However, only some are appropriate for certain types of data. Tools are chosen based upon the type of measurement they measure as well as the type of data people wish to observe. Data scientists use the term *observation* to describe data collection, regardless of whether or not a human is involved in the collection.

2. Facilitate the activity.

Device-Based Activity

Tell students that today they are going to explore a particular tool that is used to collect data. Show students the different tools, and as a class, identify each tool by name. Then place the students into small groups, and assign each group one of the tools.

Ask groups to discuss their assigned tool. Have them consider how their tool functions, what type of data it collects, and if the data are fact or opinion. Also have students consider what questions the data collected could answer.

SUPPORT—Support student learning by providing descriptions of the different tools and/or sample data collected with that tool.

EXTEND—Allow groups to research their assigned tool online to gain a better understanding of how the tool is used.

Next, ask students to create a drawing, chart, or text description that describes how their tool functions, the type of data it collects, and if that data is fact or opinion. Encourage students to be creative with their work.

3. Check for understanding.

Unplugged Activity

Have each group present their tool report to the class. After each presentation, discuss the different kinds of questions people might be able to answer with the data the tool collects. Record student responses on a whiteboard or anchor chart. Keep the board and tool descriptions available for the next lesson.

EXTEND—Students could tour their school building and identify tools used to collect data about students and the school, such as grading systems used in the main office, bulletin boards in the library tracking the number of books read by students, thermostat systems collecting temperature data, etc.

Online Resources

EXTEND—Invite students to find projects and explore how data is collected by other students. Have students visit scistarter.org and using the Project Finder tool to find relevant projects. Have students select a current project by clicking on a project name and reviewing the information. Ask them to note the goal of the project, the task, and identify what tools are used and what type of data is being collected. See the Online Resources Guide for links to the recommended resources.

www.coreknowledge.org/cksci-online-resources

LESSON 3, PART 3

Collecting, Organizing, and Presenting Data

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Use visual representations to display data.
- ✓ Draw conclusions about data from visual displays.

Instructional Activities

- student investigation
- whole-class discussion

CSTA Standards

Concept: Data Analysis

Subconcepts and Standards:

- **Collection, Visualization, and Transformation: 1B-DA-06** Organize and present collected data visually to highlight relationships and support a claim. (P7.1)
- **Inference and Models: 1B-DA-07** Use data to highlight or propose cause and-effect relationships, predict outcomes, or communicate an idea. (P7.1)

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categorize **quantitative** **questionnaire** **survey**

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interpret **organize** **represent** **visualize**

Materials and Equipment

Collect or prepare the following:

- tablet or laptop with spreadsheet and graphing software (one per group)
- tool reports from Lesson 3.2
- whiteboard or anchor chart with responses from Lesson 3.2
- paper and pencils
- examples of different types of graphs for display
- computer with school email for electronic submission of surveys
- large whiteboard or anchor chart

Advance Preparation

This is a two-part activity. In Part 1, students will formulate a question, select an appropriate collection tool, and collect data. In Part 2, students will organize and present the data. Then they will draw conclusions based on that data.

- For Part 1, coordinate with other Grade 4 teachers so students can electronically collect data from students in other classes.
- Have the tool reports and whiteboard or anchor chart from Lesson 3.2 available for display.
- Collect examples of different types of graphs to show the class.

The Core Lesson

1. Focus attention on today's topic.

Invite students to imagine they are planning a spring field trip. Their first task is to decide where to go and what to bring. Have students brainstorm possible questions they should ask, such as, "What is your favorite snack?" "What is your favorite activity?" "What kind of transportation can we use to get to a location?" Record responses on the whiteboard or anchor chart.

Pick a question from the students' responses—for example, "What is your favorite snack?" Ask students to consider some of the characteristics of a snack that might make it a good snack to take on a field trip, such as something that would travel well, not need refrigeration, not require much cleanup or need utensils, be healthy, etc. Point out that there are certain snacks that might be good to take, such as a piece of fruit, whereas others might not be so good, such as ice cream, which might melt. Explain that being specific with a question helps us collect useful data makes it easier to interpret that data. **Ask:** How could we make the question more specific so that the answers would be more useful? Encourage students to think about how they could word the question to be more specific, such as "What is your favorite fruit for a field trip snack?"

Next, present the tool reports and responses from Lesson 3.2. Remind students these are some of the tools we can use to collect data and the types of questions that the different tools can help us answer. **Ask:** Which of these tools could help you collect data about the field trip snack question? Guide students to see that because the question asks for an opinion, the best tool for collecting information would be a survey or questionnaire. If needed, explain that a survey is a list of questions used to gather information about individuals or a group of people.

Ask students to consider how they might use a survey to collect the data. For example, how will students keep track of the responses to questions? Who should they ask? Only their friends? Only students who are nine years old? Only students in the class? Only students at their school in Grade 4? Explain to students that their question should help them identify whom to collect data from. For example, if the field trip is for all Grade 4 students in the school, then the most useful data would come from asking most or all of the Grade 4 students in their school.

Tell students that after they collect data, they need to categorize it and create visual representations of the data they collected. (See **Know the Standards** 1.) Explain that to categorize data means to organize things into groups that share the same feature or have something in common. To visualize data, people can construct graphs and tables. Display the examples of each type of representation to the class, and discuss how the different tables and charts represent data and are constructed.

2. Facilitate the activity.

Unplugged Activity

Tell students they will design and conduct an experiment to collect data on a question that they want to investigate related to Grade 4 students at the school. Then they will try to answer the question by collecting, categorizing, and organizing the data.

Part 1: Pose Questions and Collect Data

Have students team up in groups of two to four, and then work together to choose a question to ask classmates that would render some useful information. Ask them to consider a context, or reason for asking the question, and refine their question based on that. You might wish to remind them of the field trip example - the

Know the Standards

1. 1B-DA-06 Collection, Visualization, and Transformation

Data are often sorted or grouped to provide additional clarity. Data points can be clustered based on commonalities between the data points, and not labeled initially. For example, a series of days might be grouped by temperature, air pressure, and humidity and then later categorized as fair, mild, or extreme weather. The same data could be manipulated in different ways to emphasize particular aspects or parts of the data set. For example, when working with a data set of popular songs, data could be shown by genre or artist. Simple data visualizations include graphs and charts, infographics, and ratios that represent statistical characteristics of the data. An important concept for students to begin understanding is that the visual representation of their data impacts how that data will be interpreted. For example, on a bar graph, the bars must be the same width, while on a pictograph, the symbols should be evenly spaced.

context was planning a field trip and they needed to determine appropriate snacks to bring. Point out to students that their question should require answers that are words or opinions rather than numbers.

> **SUPPORT**—Encourage students to write questions that are close-ended, giving students options to choose from rather than open-ended questions. For example, "What is your favorite fruit?" could produce too many different responses, but asking "Which of the following is your favorite fruit for a field trip snack?" and giving specific choices—such as apple, orange, banana, other—can help make organizing and interpreting the data easier.

Next, have students decide how to collect the data. Remind them to consider not just how they will keep track of responses but also from whom they will collect data.

> **SUPPORT**—Assist students with ideas for devising a process to collect data so that all Grade 4 classes in the school are represented. For example, you might suggest that rather than obtaining answers from just the students in their class, they might ask at least ten students in each class.

Bring the class back together, and have selected students share their question and their strategies for collecting data. Encourage students to describe how they will record the data they collect, how they will know when they have responses from all the students, and how they will make sure each student is not counted twice. After the discussion, allow each group to make revisions to their data collection plan as necessary.

Give students time to collect their data. To prevent interruptions in other classrooms, you should suggest having students submit their surveys to other classes electronically.

Part 2: Categorize, Visualize, and Draw Conclusions

Explain to students that they will now categorize and create visual representations of the data they collected and draw conclusions based on those representations. (See **Know the Standards** 2.)

Know the Standards

2. 1B-DA-07 Models and Inferences

Computer science and science use data to make inferences, theories, or predictions based upon data collected from users or simulations. Basing inferences or predictions on data does not guarantee their accuracy; the data must be relevant and of sufficient quantity. An example of irrelevance is using eye color data when inferring someone's age. An example of insufficient quantity is predicting the outcome of an election by polling only a few people. In early grades, students learn about the use of data to make simple predictions. As they progress, students learn how models and simulations can be used to examine theories, understand systems, and how predictions and inferences are affected by more complex and larger data sets.

Have students regroup into their original teams. Then have them look at their data recording sheet. **Ask:** Does the data you collected answer your original question? Why or why not? Explain that when we collect data, it is helpful to first organize it and then represent it visually to help us know the answer.

Ask students to construct a table or chart to group their data into categories based on their answer choices from their surveys. Then have students visually represent that data using two different graphs or tables.

> **SUPPORT**—To help support struggling students, encourage teams to divide up the tasks. For example, two students could be responsible for organizing the data, and the other two would create the charts.

After students have completed their graphs, explain that they should make a quantitative statement about their findings. Tell students that *quantitative* means something that can be measured, so a quantitative statement usually has a number in it. For example, the statement "Six students liked apples best, ten students liked oranges best, two students like bananas best, and eight students liked other" is a quantitative statement.

Have students use the charts and their quantitative statements to answer their original question.

3. Check for understanding.

Unplugged Activity

Have students present their questions, their data collection process, their graphs and tables, and their conclusions to the class. **Ask:** What does it mean to collect data? What does it mean to categorize data? Which graphs do you believe give the best visual representation of your data and why? What conclusions could you draw from your data?

> **CHALLENGE**—Invite students to write an opinion piece stating a claim based on their original question and support it with evidence from the data they collected.

> **EXTEND**—Students could collect temperature data over a week and then use it to create a data table and line graph. They could then use the graph to communicate what the weather was like that week.

LESSON 4, PART 1

Solving Problems with Planning and Teamwork

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Define *roles* and *collaboration*.
- ✓ Recognize the importance and advantage of teamwork.

Instructional Activities

- student reading
- whole-class discussion
- whole-class activity

CSTA Standards

Concepts:

- Algorithms and Programming
- Impacts of Computing

Subconcepts and Standards:

- **Program Development: 1B-AP-13** Use an iterative process to plan the development of a program by including others' perspectives and considering user preferences. (P1.1, P5.1)
- **Program Development: 1B-AP-16** Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development. (P2.2)

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collaboration **planning**

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fundraiser **teamwork**

Instructional Resource

Student Reader

Ch. 4

Student Reader, Chapter 4
Solving Problems with Planning and Teamwork

Materials and Equipment

Collect or prepare the following:

- two or three large blankets, sheets, or tablecloths

The Core Lesson

1. Focus attention on today's topic.

You may choose to do the following activity as a whole-class demonstration or individual teams as time permits. Place students into two or three teams, or choose five or six students to demonstrate. Lay out two or three (depending on the number of teams) blankets in a space in the room. Each team will stand on a blanket, leaving some space at one end. Each team then needs work together and problem-solve how to turn over their blanket without coming off of it. As students finish, ask them what they had to do in order to be successful at completing the task.

2. Read and discuss "Solving Problems with Planning and Teamwork."

Student Reader

Ch. 4

Read together or have students read independently "Solving Problems with Planning and Teamwork," in the Student Reader. The selection introduces the idea that when people come together to share their ideas, they are working as a team.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 15

Tell me about a time when you were part of a team and had to show teamwork.

» Student responses will vary but should include examples of teamwork.

Pages 16–17

How is Lin's family collaborating?

» They are making a list of the ingredients they need and buying what they need. Lin is chopping the pineapple, Dad is measuring the flour, and Mom is getting the pans ready. Then they package the items together.

Why did collaborating make it possible for Lin's family to provide treats for the fundraiser?

» Lin's family worked together to come up with bakery treat ideas. When they did that, they were able to choose the best ones to bake. Then they were able to time everything so they could bake the treats before the fundraiser.

3. Check for understanding.

Unplugged Activity

When you collaborate with other people, you work as a team to get a task done. Think about how baking the bakery treats for the fundraiser would have gone if Lin's family did not collaborate. Without collaboration, the family may have made too many treats, spent too much time debating about the kinds of treats to make and then not had enough time to make the treats. Collaboration allows people to work together as a team so that they work effectively and efficiently. **Ask:** Are there ways you can use collaboration in our classroom or at home to make something run more smoothly?

SUPPORT—For students who may need support, offer examples of how people work together as a team in many different tasks. You may discuss sports and how the common goal of a soccer team, for example, is to pass the ball and work together to score goals.

EXTEND—For students who are interested in learning more about fundraising or collaborating, have them create posters advertising a food can collection for your local food bank.

LESSON 4, PART 2

How Can People Work as a Team to Find a Solution?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Work collaboratively to solve a design problem.
- ✓ Use an iterative process to build a structure that meets specific criteria.

Instructional Activities

- student investigation
- whole-class discussion

CSTA Standards

Concepts:

- Algorithms and Programming
- Impacts of Computing

Subconcepts and Standards:

- **Program Development: 1B-AP-13** Use an iterative process to plan the development of a program by including others' perspectives and considering user preferences. (P1.1, P5.1)
- **Program Development: 1B-AP-16** Take on varying roles, with teacher guidance, when collaborating with peers during the design, implementation, and review stages of program development. (P2.2)
- **Social Interactions: 1B-IC-20** Seek diverse perspectives for the purpose of improving computational artifacts. (P1.1)

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collaboration **design** **planning** **teamwork**

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development **perspective** **role**

Materials and Equipment

Collect or prepare the following:

- building elements, such as foam beads and chenille sticks, marshmallows and lollipop sticks, gumdrops and toothpicks (about 30 pieces of each per group)
- tape (about 10 pieces per group)
- paper
- ruler or measuring tape for checking height (1 per group)
- book for testing strength (1 per group)
- stopwatch or timer with second counter (1 per group)
- large whiteboard
- digital camera or phone camera

The Core Lesson

1. Focus attention on today's topic.

Tell students that today they are going to work as a team to build a structure. Ask students to share one element of being a good team member, such as listening to others' perspectives, respect, trusting each other, working hard, or taking on individual roles. Can they name some of the roles involved in various teams, such as a soccer team, a computer program development team, a restaurant staff, or a book club? Prompt students to consider how in order to be respectful, each role must work together and team members must be respectful of other perspectives. (See **Know the Standards** 2.)

2. Facilitate the activity.

Unplugged Activity

Tell students that they will have to work together to construct a tower out of everyday materials. The tower should be at least three inches tall and strong enough to hold a book for at least 10 seconds.

On the whiteboard, write the following rules:

1. Use only the supplies provided to build a tower.
2. The tower can be any shape, but it has to be at least three inches tall.
3. The tower must support the weight of a book for 10 seconds.

Place students into groups of three or four, and review the rules of the challenge.

Provide each group with a set number of supplies, pointing out that this will be all the students have to work with.

Challenge the groups to think about the problem and plan out their method of building their towers. You may want to provide pieces of paper and pencils for students to sketch out or write down their ideas. Encourage students to assign different roles to each team member, such as designer, builder, tester, and notetaker. (See **Know the Standards** 1.)

After teams have a plan, ask students to begin building. They should alert you when they think they've met the challenge. Have the team test the structure as you watch Is it taller than three inches? Does it hold a book for at least 10 seconds? If not, have students start a cycle of planning, fixing, and testing again until the challenge has been met.

Take a picture of the successful towers to upload to a class website.

3. Check for understanding.

Unplugged Activity

Prompt student groups to share their experiences with teamwork—focusing on how they practiced respect, trust, listening, and clear communication. Ask them to describe their individual roles in the team and how they were able to overcome any challenges they might have had. **Ask:** Which part of the design process did you like best? Which part did you like least? Discuss the importance of each stage of the design process.

EXTEND—Challenge students to try doing the same activity with different materials, different height requirements, and/or different weight requirements.

Know the Standards

1. 1B-AP-13 and **1B-AP-16 Program Development**

Planning and collaboration are important parts of the iterative process of program development. Planning involves having students outline key features, time and resource constraints, and user expectations. Some ways students should document plans are by using a storyboard, flowchart, or story map. Collaboration provides for the contributions and feedback of others and can often lead to better outcomes than working independently. Help students understand that communication, conflict resolution, and task management are all necessary parts of creating a plan before beginning to build a program.

2. 1B-IC-20 Social Interactions

People can work in different places and at different times to collaborate and share ideas when they use technologies that reach across the globe. These social interactions affect how local and global groups interact with each other and how these interactions can change the nature of groups.

LESSON 5, PART 1

Data, Programmers, and Problem-Solving

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Explain how algorithms provide instructions to a computer.
- ✓ Define *variable*.

Instructional Activities

- student reader
- whole-class discussion

CSTA Standards

Concept:

Algorithms and Programming

Subconcepts and Standards:

- **Algorithms: 1B-AP-08** Compare and refine multiple algorithms for the same task and determine which is the most appropriate. (P6.3, P3.3)
- **Variables: 1B-AP-09** Create programs that use variables to store and modify data. (P5.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

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algorithm **if/then statements** **variable**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

icon **scroll**

Instructional Resource

Student Reader

Ch. 5

Student Reader, Chapter 5
Data, Programmers, and Problem-Solving

Materials and Equipment

Collect or prepare the following:

- internet access and the means to project images/video for whole-class viewing
- index cards for student vocabulary deck (three per student)
- three or four buckets for the support activity

The Core Lesson

1. Focus attention on today's topic.

Ask students to think about having a bowl of cereal in the morning. When you have a bowl of cereal, there are certain steps you follow in order to eventually eat your breakfast. What would happen if you took out the milk and cereal box but did not take the bowl out? Would you pour the milk into the cereal box? Tell students that following a series of steps or directions is important and sometimes completely necessary in order to achieve the outcome you want.

2. Read and discuss "Data, Programmers, and Problem-Solving."

Student Reader

Ch. 5

Read together or have students read independently "Data, Programmers, and Problem-Solving," in the Student Reader. The selection introduces the idea that a computer device can be used to record a series of steps.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 19–20

What if Dad wanted to make pumpkin bagels?

» Then Dad would substitute pumpkin for the blueberries.

What is an algorithm?

» An algorithm is the set of instructions that a computer follows.

How are computer algorithms and recipe instructions similar?

» Recipe instructions are an exact set of steps you need to follow in order to get the food you want. Computer algorithms act the same way, in that the steps need to be in order or done correctly so that the computer does what you want it to do.

Page 21

What is a variable?

» A variable is a value that is not exactly the same each time the computer runs the program.

If Lin's high score was recorded the last time he played his video game, what would happen if he scored even higher the next time he played?

» The computer will store the variable but with a new name, or it may replace the old score.

3. Check for understanding.

Device-Based Activity

Go to a website that offers recipes for different meals. Explain and show students how each recipe contains different options to choose from. We call the different options variables. Each time we select a different variable, we end up with different results. variables. For example, you have the variable of breakfast, lunch, dinner, or dessert recipes. Then you may have the variable for protein type, and the list goes on. Pull up the main page of the website. Have students list the different variables they see listed.

Unplugged Activity

SUPPORT—For students who may need additional instruction on variables, you may offer them a different explanation for variables. Have several buckets available, and explain that variables are like buckets. We use these variables, or buckets, to store information that might change and can be used later. For example, if you were programming a game, you might have variables, or buckets, labeled in different sections, such as "the score" or "player names." The "score" variable, or bucket, would contain and keep track of the current score of the player. The "player names" variable would remember the names of different people who had played the game.

Unplugged Activity

CHALLENGE—For students who may enjoy learning more, you may have them think about their own experiences with video games and have them write down all of the variables they can think of that are in their favorite game.

Device-Based Activity

EXTEND—To offer extension for students who are enjoying learning about variables, you might discuss the different types of computer variables there are. You may offer students the opportunity to research each type of variable and learn about the way each stores data.

Know the Science

Computer programmers create the code that tells computers, mobile devices, and software how to run. Programmers have their own languages in which they code (for example, HTML for websites or Java for gaming). Variables store a single type of value. For example, if you had a box and labeled it "Toys" and then put a doll inside it, the programming terms might say that "Toys" is the variable name and "doll" is the value.

LESSON 5, PART 2

How Can a Problem Be Solved in Different Ways?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Compare different ways to solve the same problem.
- ✓ Recognize that different solutions exist for the same problem.

Instructional Activities

- whole-class activity
- whole-class discussion

CSTA Standards

Concept: Algorithms and Programming

Subconcept and Standard: Algorithms: 1B-AP-08 Compare and refine multiple algorithms for the same task and determine which is the most appropriate. (P6.3, P3.3)

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algorithm **code** **compare** **design**

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programmer **sequence**

Materials and Equipment

- paper and pencils (per group)
- chalk or painter's tape
- measuring tape
- stopwatch or timer
- large whiteboard or anchor chart

Advance Preparation

Collect or prepare the following:

- Prior to class, mark out a 5 x 5 grid consisting of 1 ft. x 1 ft. squares using chalk on a blacktop or painter's tape on the classroom or gym floor. Place a star in a corner square to indicate "start" and an X on the opposite side of the grid to indicate "end."
- On the whiteboard or anchor chart, draw a 3 x 3 grid consisting of equal-sized squares. Draw a star in one corner and an X in a square on the opposite side.

The Core Lesson

1. Focus attention on today's topic.

Remind students that an algorithm is a sequence of steps for solving a problem or completing a task. Explain that we use algorithms every day without realizing it. For example, we follow steps to brush our teeth or make a sandwich.

Direct students' attention to the grid on the whiteboard or anchor chart. **Ask students** How can we write an algorithm to move one block at a time from the start of this maze (the star) to the end (the X)? Invite a student to share his or her thinking. Record responses on the whiteboard or anchor chart. Then ask another student to share a different way of moving through the maze, and record his or her response.

Have students compare the two algorithms and highlight any differences. Point out that the algorithms may start or end with steps in different directions or one may have more steps than another, but they have the same result. (See **Know the Standards**.)

Know the Standards

1B-AP-08 Algorithms Different algorithms can achieve the same result, though sometimes one algorithm might be most appropriate for a specific situation. Students should be able to look at different ways to solve the same task and decide which would be the best solution.

2. Facilitate the activity.

Unplugged Activity

Tell students that they will have to work together to develop an algorithm to move a human "robot" through a maze using the fewest steps.

On a clean whiteboard or anchor chart, write the following rules:

1. You will have three minutes to write out your code for moving from the starting block to the ending block.
2. You may only move one block at a time: forward, backward, right, or left. You cannot move diagonally.
3. Try to look for the fastest way through the maze (the fewest number of blocks from one point to another).
4. Once a "robot" starts moving, you are not allowed to change your algorithm.

Organize students into four or five groups, and review the rules of the challenge. Ask each team to select someone to be the robot, someone to be the caller, and someone to be the counter. The rest of the team will be the programmers.

Show students the maze you have constructed. Then set a timer for three minutes, and have the programmers work together to write their algorithm using paper and pencils. Once time is up, ask students to put their group name on the code and turn in their algorithms.

Invite one group forward to start the challenge. Hand the caller the group algorithm sheet, and ask the robot to stand on the start of the maze. On "go," the caller should read off the instructions to the robot one at a time, and the robot must move exactly as told. The counter should record each time the robot enters a different square. When the robot reaches the end or gets stuck, the turn is finished.

Repeat the challenge with each of the remaining groups.

> **EXTEND**—If time permits, modify the maze by placing obstacles in a square or two. Then repeat the activity, telling students that the robots must go around any obstacles in the maze.

3. Check for understanding.

Unplugged Activity

Prompt student groups to share their results with the class. Discuss what worked and what did not. **Ask:** Whose robots made it to the finish? Whose did not? For those that made it to the finish, which group or groups did it in the fewest number of steps? Invite students to share ideas for how to improve each algorithm.

LESSON 5, PART 3

Variables and Data

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Model using variables to produce different outcomes.

Instructional Activities

- whole-class activity
- whole-class discussion

CSTA Standards

Concept: Algorithms and Programming

Subconcept and Standard: Variables: 1B-AP-09 Create programs that use variables to store and modify data. (P5.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

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value **variable**

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label **modify** **name** **placeholder**

Materials and Equipment

Collect or prepare the following:

- index cards (3 per student)
- pencil or pen (1 per student)
- 3 boxes or bins to hold index cards
- large whiteboard

Advance Preparation

- Before class, label the boxes or bins that will hold the index cards. One should be labeled "color," one should be labeled "animal," and one should labeled "name."

The Core Lesson

1. Focus attention on today's topic.

Ask students to think about how we organize and store things. Do students ever keep things in boxes or containers? Are any of those boxes or containers labeled with what is supposed to go inside, like "toys" or "socks" or "books"? Have students consider what they could do if they wanted to store information instead of objects. Then explain that a variable is like a container that holds information. Variables are used in computer science. The name of a variable stays the same, but the information inside a variable can change. (See **Know the Standards**.)

On the board, draw two rectangles. Label one "thing" and one "age." Above each rectangle write a word or number that matches that label, such as "desk" and "3." Invite several students to come up with additional words for each label. Write their suggestions in the appropriate space above the words you have written. Point out that the rectangles represent variables for things and ages and that the words and numbers are the values for those variables.

Next, write the following on the board.

My _____ is _____ years old.

Label "thing" under the first blank, and label "age" under the second blank.

Ask one student to pick one of the "thing" values on the board, and ask another student to pick an "age" value. Fill in the blanks using the chosen values, such as "My house is 1 year old" or "My shoe is 20 years old." Then have other students pick new values. Erase just the old values, and write in the new ones.

Know the Standards

1B-AP-09 Variables Variables are used to store and modify data, such as using mathematical operations to add to the score of a game or using a variable as a countdown timer. The data type (e.g., words, numbers, characters, or images) determines the values and type of operations that can be performed with that data.

2. Facilitate the activity.

Unplugged Activity

Place the three labeled boxes or containers on a table, and hand out the index cards. Explain to students that they will be play a word game using variables!

Ask students to think of an animal, a color, and a name. They should write the words on an index card, with one word per card. When they have finished, ask each student to come forward and place their cards in the appropriate containers: animals in the "animal" container, colors in the "color" container, and names in the "name" container.

Erase the whiteboard and write:

I have a _____ _____ named _____.

Under the blanks, write "color," "animal," and "name."

Ask for a volunteer to help you fill in the blanks. Have the student come to the front of the class and select a card from the "color" container. Write that color above the blank space. Continue with the "animal" and "name" variables. Read the full sentence. Then erase the values in the blanks, and have a second student volunteer repeat the steps. Continue for several more rounds.

> **EXTEND**—Have students make up a short story (three or four sentences) that contains the following variables: object, location, number, adjective. The story can be about anything, such as a trip, a party, or a daily routine. Remind them they should label the variables so someone else knows what kind of values are needed. After they have written their story, ask them to partner with another student. Have one student ask the other student for words to go with each labeled blank space. Then have the student read the new version of the story out loud.

3. Check for understanding.

Unplugged Activity

Remind the class that all variables have a name and a value. **Ask:** How did we use variables to make our sentences? What were the names of the variables we used? (color, animal, name) What were the values? (the words and numbers the students supplied)

LESSON 6, PART 1

Solving Problems with Codes

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Break a process down into steps (decomposition).
- ✓ Explain the coding concepts of sequences, events, and loops.
- ✓ Describe grouped components of a system or program (modularity).

Instructional Activities

- student reading
- whole-class discussion

CSTA Standards

Concept: Algorithms and Programming

Subconcepts and Standards:

- **Modularity: 1B-AP-11** Decompose (break down) problems into smaller, manageable sub problems to facilitate the program development process. (P3.2)
- **Control: 1B-AP-10** Create programs that include sequences, events, loops, and conditionals. (P5.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

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code **event** **loop** **sequence**

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decomposed

Instructional Resource

Student Reader

Ch. 6

Student Reader, Chapter 6
Solving Problems with Codes

Materials and Equipment

Collect or prepare the following:

- internet access and the means to project images/video for whole-class viewing
- index cards for student vocabulary deck (3 per student)
- dot matrix enlargement, or dot matrix found online that can be displayed
- access to marching band drill charts for extension activities

The Core Lesson

1. Focus attention on today's topic.

On chart paper or a whiteboard, draw a simple connect-the-dots shape. (You may choose a tree or search online for an easy dot matrix.) **Ask:** What happens when I begin to draw the lines in the correct order of the numbers? Listen to student responses, and follow up by asking, "And what happens if I do not draw the lines in correct order?" Engage students in a discussion that gets them thinking about processes and why they exist.

2. Read and discuss "Solving Problems with Codes."

Student Reader

Ch. 6

Read together or have students read independently "Solving Problems with Codes," in the Student Reader. The selection introduces the idea that when you do something in a particular order, you are creating a chain of events that follow one another.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 23

How do the band members learn the steps for their performance?

» They get their part of the performance, or sequence, by viewing it on a piece of paper or digitally. They learn their parts and then come back together for the whole performance.

What else can you think of that moves in a sequence?

» Student answers may vary but might include seeing a prep station in a deli sandwich shop.

What can you think of that uses sequences that can be decomposed into events and loops?

» Student answers may vary but may include a vehicle turning on a synchronized light show, or learning a dance in a show.

Page 24

What is code?

» Code is the events, sequences, and loops for a computer to complete.

Page 25

How is the marching band like computer programming?

» Students should be able to summarize Lin's presentation in their own words to show how the marching band is like computer programming.

3. Check for understanding.

Unplugged Activity

In this chapter, computer programming is compared to a marching band. As students reflect on the similarities of computer code to a marching band, ask them to think about why it is important to understand computer code in its parts. Explain to students that in order to write computer codes, you must be able to see that there are sequences and events that make up a large part program.

SUPPORT—It is important for students to understand the marching band concepts in this lesson. If students have not seen this type of performance before, it would be helpful to have students watch a performance.

CHALLENGE—Provide students with a simple drill chart for learning the moves of a marching band. Group the students, and see if they can set themselves up for performing the moves. Ask students to reflect on what they needed to be able to do in order to assign the tasks (decompose the tasks and then come together).

LESSON 6, PART 2

How Can a Task Be Broken Down into Steps?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Decompose a process.
- ✓ Describe how decomposition can make difficult problems easier to solve.

Instructional Activities

- student investigation
- whole-class discussion

CSTA Standards

Concept: Algorithms and Programming

Subconcept and Standard: Modularity: 1B-AP-11 Decompose (break down) problems into smaller, manageable sub problems to facilitate the program development process. (P3.2)

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decomposition **sequence**

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algorithm **code** **event** **program** **task**

Materials and Equipment

- paper and pencil (per pair)
- large whiteboard or anchor chart

Advance Preparation

Collect or prepare the following:

- Before class, develop a clapping sequence or "hand jive" sequence that you will demonstrate to the class. The sequence should be relatively long and/or complex so that students will find it difficult to remember it without it being broken down into parts.

The Core Lesson

1. Focus attention on today's topic.

Announce that you are going to show students a hand motion sequence that you just learned! Show students the sequence of hand motions you developed. Then ask students to recreate the sequence without showing it to them again or explaining the parts.

> **SUPPORT**—To support students who may have difficulties with coordinated motor skills, you may wish to create the sequence using tone blocks or colored lights.

Lead a discussion on how you could make the sequence easier for others to learn. Guide students to the idea that it would be easier to break the sequence down into parts. Explain that breaking something into parts is called decomposition. (See **Know the Standards**.)

Model how to break the sequence into parts. On the whiteboard or anchor chart, draw a three-column table. Label the columns "Part," "Drawing," and "Notes." Record each part of the sequence in the chart, using rough sketches to indicate a particular hand motion. You may also want to model how to number or name each part. **Ask students** Do you think it is easier to learn the sequence when it's broken down into parts? Why or why not?

Know the Standards

1B-AP-11 Decomposition Decomposition is the act of breaking down a task into multiple, simpler tasks. Programs can be broken down into smaller parts to facilitate their design, implementation, and review. Decomposition facilitates aspects of program development, such as testing, by allowing people to focus on one piece at a time. Decomposition also enables different people to work on different parts at the same time.

2. Facilitate the activity.

Unplugged Activity

Place students into pairs. Give each pair of students paper and pencils to record their sequences. Encourage students to work collaboratively to develop their sequences, discussing moves, recording each part, testing it, and fixing any problems. Suggest that students use the notes column to clarify any potentially confusing steps. For example, if the sequence involves opening a closed fist one finger at a time, they could draw an open hand in the drawing column and write "open fingers one at a time" in the notes column.

> **SUPPORT**—Some students may have difficulty creating drawings that indicate a particular motion. For these students, you may wish to develop a set of pre-drawn diagrams they can copy to indicate different motions.

Have pairs of students swap their designs and test them before completing the activity.

3. Check for understanding.

Unplugged Activity

Select several pairs to teach the class their finished sequence using their decomposition design page. If possible, display their design sheet using a projector. Then lead a class discussion about how breaking down the sequence into parts helped both the design process and in teaching the sequence. Point out that decomposition allows different people to work on different parts of a task at the same time. Ask students how they might divide the task of writing the hand motion sequence.

> **EXTEND**—If time permits, ask students to think about how computer programmers might use decomposition in their work. For example, if programmers want to create a game, one way to break down the task is to have different people working on different levels of the game. Another way is to divide the task by type: some work on the background art, some work on the sound, and some work on the action.

> **CHALLENGE**—Challenge students to think of ways that decomposition is used in their lives, for example in sports, dance, music, and cooking. Have students research how sequences are taught in a particular area, and make a copy of a related drill chart for that activity.

LESSON 6, PART 3

How Does a Computer Know to Perform a Specific Action?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Recognize day-to-day examples of events, sequences, loops, and conditionals.
- ✓ Develop a board game that includes events, sequences, loops, and conditionals.

Instructional Activities

- student investigation
- whole-class discussion

CSTA Standards

Concept: Algorithms and Programming

Standard: Control: 1B-AP-10 Create programs that include sequences, events, loops, and conditionals. (P5.2)

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conditional **event** **if/then statement** **loop**

program **sequence**

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action **control**

Materials and Equipment

Collect or prepare the following:

- game construction materials: board materials (such as poster board, cardboard boxes, and/or file folders); construction paper, scrapbook paper, stickers, index cards, crayons, markers, colored pencils, scissors, glue sticks, tape, game pieces (such as water bottle caps, mini erasers, and/or small manipulatives), spinners and/or dice (whole class)
- writing paper, pencils, and pens (per group)
- storage boxes or bins for completed games
- several common board games for demonstration
- large whiteboard or anchor chart

Advance Preparation

- Before class, set up a game construction materials table, and place the game construction materials in the area.
- Acquire several common board games.
- On the whiteboard or anchor chart, write the following terms and definitions:

  Event: tells a program to detect when something happens and take action when it does

  Sequence: the order in which instructions or moves take place

  Loop: a repeating set of instructions

  Conditional: tells a program what to do when a certain condition is true

The Core Lesson

1. Focus attention on today's topic.

Begin by asking students to name their favorite games to play. Most will probably name active games or video and computer games. Explain that other types of games were popular before computer games were around. These games are called board games. They are played on a board with different pieces.

Show the students the board games you brought to class. Point out that many roll-and-move games have certain features in common. There is usually a starting point, an ending point, and a path on the board that pieces move on. There is a way to tell players how to move around the board with the pieces. This is usually done using a spinner, dice, or cards. There are actions that happen when a player lands on certain spots or draws certain cards.

Make a comparison between how a board game is played and computer programming. Point out that rolling a die or spinning a spinner is an event: it tells the player to take action. The path on the board that the player follows is a sequence: a step-by-step set of instructions on how to move. If a player has to repeat the same actions or moves several times—such as moving three spaces

forward on the board—this is a loop. And if a player has to take action depending on a specific event, such as landing on a certain spot that says "move back two spots," this is a conditional statement.

> **SUPPORT**—To help students better understand conditional statements, give students a series of if/then statements, such as "If I _____, then you ____," as examples. For instance, "If I touch my nose, then you touch your toes," or "If I turn in a circle, then you turn in a circle."

2. Facilitate the activity.

Unplugged Activity

Place students in groups of three or four, and supply each group with paper and writing instruments. Explain to students they are going to design and construct their own board games. They can choose any theme they wish, such as a treasure hunt, an underground adventure, or a trek through a fairy garden, but they have to keep in mind certain conditions. Write the following on a clean whiteboard or anchor chart.

1. There should be a theme/setting and title.
2. There should be a goal (how someone wins the game).
3. There has to be a starting point and an ending point.
4. There has to be some sort of path from the starting point to the ending point.
5. There need to be game pieces to represent players.
6. There needs to be a method for telling players how to move along the path.
7. There needs to be at least one special spot along the path that forces players to move back, move forward, or change their route.

> **SUPPORT**—For students who may have a hard time coming up with ideas, help guide them with some questions, such as "What is the object of the game?" "Who are the players?" "How many people can play?" "Do all players follow the same path?" "Are there any shortcuts?" "Are there any bonuses for landing on a spot?"

Ask students to spend some time with the others in the group to plan out their theme and game. Suggest they sketch out a rough board design. Then direct them to the game construction materials, and allow them to gather supplies they might need.

After students construct their games, ask them to write an instruction manual so that others can play. The rules should include step-by-step instructions for how to play, define what causes things to happen in the game, and describe the physical game features.

3. Check for understanding.

Unplugged Activity

Have students present their completed games to the class. Have students discuss which parts of their games use events, sequences, loops, and conditionals and how they made those choices. Then ask students store their games for use in Lesson 6.4.

LESSON 6, PART 4

How Can a Program Be Modified to Do Something Different?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Modify a sequence to steps to produce an altered outcome.

Instructional Activities

- student investigation
- whole-class discussion

CSTA Standards

Concept: Algorithms and Programming

Subconcept and Standard: **Modularity: 1B-AP-12** Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features. (P5.3)

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incorporate **modify** **module**

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code **conditional** **event** **loop** **sequence**

Materials and Equipment

Collect or prepare the following:

- games from Lesson 6.3
- writing paper and pencils or pens (per group)
- large whiteboard or anchor chart

Advance Preparation

- Complete Lesson 6.3 with students.

The Core Lesson

1. Focus attention on today's topic.

Invite two groups of students to demonstrate their games from Lesson 6.3. As they do the walk-throughs, ask the rest of the class to think about the different elements of the game, such as theme, goal, number of players, rules, movement of players on the board, number of special spots, etc.

Explain that game developers often design games that can be broken down into smaller pieces of code, or modules, which can be changed or used later to easily modify a game. (See **Know the Standards**.) Lead a discussion about which modules students can identify in the games they play.

2. Facilitate the activity.

Unplugged Activity

Have students regroup into their original groups from Lesson 6.3. Ask them to retrieve their games. Distribute paper and writing instruments.

Explain to students that today they will be modifying one aspect of their game. For example, they might want to change the theme or setting from pirates to astronauts. They should look at their existing game and decide what would have to change (art, references to pirates in the instructions, possibly player tokens) and what would stay the same (the placement of the starting and ending points, the number of players, the rules, the sequence of the path, the special spots).

Know the Standards

1B-AP-12 Modularity Modularity refers to smaller portions of a program that may complete their own procedure. These modules (smaller portions) can be incorporated into new or existing programs. For example, students could modify prewritten code from a single-player game to create a two-player game with slightly different rules, remix and add another scene to an animated story, use code to make a ball bounce from another program in a new basketball game, or modify an image created by another student.

On the whiteboard or anchor chart, write the following possible parts that could be changed:

1. Theme/setting
2. Goal
3. Number of players
4. Placement of starting and ending points
5. Number or position of path from start to end
6. Rules
7. What happens on the special spots

Ask students to decide as a group which one of the parts to change. Tell students they will not have to construct a new game but instead should just write up a plan for how the game will be revised. They should try to reuse their original design when possible.

Allow students time to make their revisions. Encourage them to copy over the parts of their original plan that are not being changed.

> **SUPPORT**—Some students may find it easier to identify what needs to change by first highlighting or marking any references to that element in their original design or rules.
>
> **CHALLENGE**—Have groups compare games with another group. Ask them to identify one module in the game that they would like to use in their own game.

3. Check for understanding.

Unplugged Activity

Ask students to count how many parts of their game were new and how many were reused in their new games. Ask students which might be easier: to create a new part from scratch or to incorporate portions of the old game to develop the new game. Do they think the same would be true if they were writing computer code?

LESSON 7, PART 1

Testing Programs

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Explain the need to test designs and systems.

Instructional Activities

- student reading
- whole-class discussion

CSTA Standards

Concepts:

- Algorithms and Programming
- Impacts of Computing

Subconcepts and Standards:

- **Program Development: 1B-AP-15** Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended. (P6.1, P6.2)
- **Culture: 1B-1C-19** Brainstorm ways to improve the accessibility and usability of technology products for the diverse needs and wants of users. (P1.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

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testing **usability**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

debugging

Instructional Resource

Student Reader

Ch. 7

Student Reader, Chapter 7
Testing Programs

Materials and Equipment

Collect or prepare the following:

- internet access and the means to project images/video for whole-class viewing
- access to blocks for the extension activity
- access to online resources for simple student debugging activities for the extension activity

The Core Lesson

1. Focus attention on today's topic.

Begin a discussion with students about books in a series. You may choose your favorite picture book series to hold the discussion or choose one that fits your students well. Ask students to think about how long it might take for an author to write another book in the series. Engage students in a short discussion about the process of writing, editing, and publishing a book.

2. Read and discuss "Testing Programs."

Student Reader

Ch. 7

Read together or have students read independently "Testing Programs," in the Student Reader. The selection introduces the idea that Lin has been anticipating a new video game coming out. He wonders why it took so long for the game to come out when the game makers had been advertising it for such a long period of time.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Page 27

Why is it a long process to create a video game?

» It is a long process because computer programmers first come up with an idea and have to code all parts of the story. After that, they have to test it to make sure they work out all of the bugs or problems. Then they have to test it again!

Have you ever experienced a bug or problem within a game or something you were playing?

» Student answers may vary but should mention times when they experienced glitches in games they were playing.

Page 28

Why is it important to go through a testing phase when implementing new products?

» In order for you to have products that are of a quality that people want to play (or buy), you need to make sure they work correctly.

Page 29

Why is Lin glad that the game was tested before it was released?

» He is glad because he can now enjoy the game free from any errors.

3. Check for understanding.

Unplugged Activity

Engage students in a closing discussion that asks them to think about learning a new sport or dance move. In order to learn the new skill and be error free, you must practice. You will likely not be successful by practicing just one time. Tell students it is the same with computer programs: in order for code to be perfect and error free, it must be tested and retested.

EXTEND—Offer students a situation, using blocks or other materials, in which a bridge won't stand up. Then ask the students to spend time debugging the problem and fixing it so that the bridge stands independently. You may also engage in online research for additional opportunities for students to practice debugging activities.

LESSON 7, PART 2

How Can You Debug a Program?

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Evaluate step-by-step directions to accomplish a task.
- ✓ Identify and fix simple bugs in an algorithm.

Instructional Activities

- whole-class activity
- whole-class discussion

CSTA Standards

Concept: Algorithms and Programming

Subconcept and Standard: Program Development: 1B-AP-15 Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended. (P6.1, P6.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

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bug **debug**

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algorithm **code** **crash** **program** **reset**

Materials and Equipment

Collect or prepare the following:

- jar of peanut butter, initially closed (Note: if any students have a peanut allergy, you can substitute an unopened package of softened cream cheese for the peanut butter.)
- jar of jelly or jam, initially closed
- bag of sliced bread, initially closed
- paper plate
- knife
- paper towels
- writing paper and pencils (per pair)

Advance Preparation

- In this activity, you will be acting as a robot and following student directions to make a sandwich. See the Online Resources Guide for links to video support on how to do this.

  www.coreknowledge.org/cksci-online-resources

The Core Lesson

1. Focus attention on today's topic.

Ask students Have you ever wanted a robot assistant that could do all your household chores? Have students think about what would be involved in asking a robot to do a simple household task, such as folding clothes or cooking dinner. Point out that robots need to programmed to perform tasks like these. Remind students that robots and computers are very precise and will follow instructions, even if there is a mistake in the instructions. A mistake in code is called a bug, and when someone finds and fixes bugs, the process is called debugging. (See **Know the Standards**.)

2. Facilitate the activity.

Unplugged Activity

Tell students that today you are going to be a robot and the class has to program you to make a peanut butter and jelly sandwich.

SUPPORT—Depending on the level of your class, you may want to demonstrate how to make the sandwich without supplying directions so students have a model for the task.

Know the Standards

1B-AP-15 Program Development Programs do not always run properly. Students need to understand how to test and make necessary corrections to their programs to ensure they run properly. Students successfully identify and fix errors in (debug) their programs as well as programs created by others. Debugging strategies at this level may include testing in order to determine the first place the error occurs, and fixing accordingly, or soliciting assistance from peers and online resources.

Have pairs of students write down directions for making the sandwich. Encourage them to break the procedure down into a series of numbered steps, even if the steps seem obvious. Have pairs compare directions, looking for similarities and differences in their code.

Students then take turns reading the code aloud while you act as a robot and follow the stated directions exactly, even if that results in making a mistake. Have students identify if any mistakes are made and, if so, the step where a mistake occurs. (Note: if the "program" gets out of hand, you can simply indicate the program has "crashed" and do a reset.)

Ask students to debug their program by fixing the errors in the code. They should then write a new version of the program and test it again. Have the class repeat the debugging process until you (as the robot) successfully make a normal peanut butter and jelly sandwich.

3. Check for understanding.

Unplugged Activity

Discuss the activity with the class. Ask students What are some of the bugs you identified in your program? (Examples might include not indicating that a jar of jelly or loaf of bread should be opened before making the sandwich, that the peanut butter should be spread with a knife, putting the wrong sides of the bread against each other, and so on.) How did you identify the bugs? (tested the program to see if it worked) How did you fix the bugs? (made the instructions more specific)

EXTEND—Place students into pairs. Ask one student in each pair to be the coder and the other student to be the robot. Have the coders give directions to the robots for drawing a simple object, such as a house. Tell students they can only use words like line or circle and can only give one step at a time. When the robots complete the drawings, have the coders check for any bugs. Then have the pairs switch roles and repeat the activity.

LESSON 8, PART 1

Making Programs Usable

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Describe factors that affect usability of computer devices and applications.

Instructional Activities

- student reading
- whole-class discussion

CSTA Standards

Concepts:

- Algorithms and Programming
- Impacts of Computing

Subconcepts and Standards:

- **Program Development: 1B-AP-15** Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended. (P6.1, P6.2)
- **Culture: 1B-1C-19** Brainstorm ways to improve the accessibility and usability of technology products for the diverse needs and wants of users. (P1.2)
- **Social Interaction: 1B-1C-20** Seek diverse perspectives for the purpose of improving computational artifacts. (P1.1)
- **Safety, Law, and Ethics: 1B-1C-21** Use public domain or creative commons media, and refrain from copying or using material created by others with permission. (P7.3)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

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credit **ethics** **permission** **usability**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

accessible **equitable** **font** **rank**

Instructional Resources

Student Reader

Ch. 8

Student Reader, Chapter 8
Making Programs Usable

Materials and Equipment

Collect or prepare the following:

- internet access and the means to project images/video for whole-class viewing
- two printed or online photos, one showing a person dressed in a fancy outfit and the other in a typical summer outfit

The Core Lesson

1. Focus attention on today's topic.

Ask students to think about getting ready for school in the morning. What do they need to do in order to get ready? Are there things they do the night before to make their morning easier? Explain to students that when we are getting ready we are preparing ourselves for the day ahead. There are steps and processes we must think about in order to successfully get ready. Tell students that when computer developers are creating, they also have things they need to think about.

2. Read and discuss "Making Programs Usable."

Student Reader

Ch. 8

Read together or have students read independently "Making Programs Usable," the Student Reader. The selection introduces the idea that accessibility and ethics are important when putting information on a website.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 30–31

Explain why Lin's family would want their website to be accessible.

» The more you make something easy or easier for an audience to understand, the more people you will reach by doing so.

Pages 32–33

When you look at a website, to whom does the content belong?

» When you look at a website, sometimes it is obvious to whom the content belongs, but not always. Someone who writes a recipe is the author of that recipe. That means the content belongs to that person, and while you may use the recipe, you cannot claim it as your own.

What does ethical mean?

» Ethical means the correct thing to do.

3. Check for understanding.

Unplugged Activity

Prompt students with the question, "How do you know when you should give credit to the author of a piece of work?" Have students turn and talk with a partner to share their ideas. Ask pairs to report their discussions. As you listen to their ideas, remind them it is important to do the right thing and give credit where it is due.

SUPPORT—For students who might struggle with the idea of when we need to give credit to the author of a recipe or other content, explain to them that it is okay to use the recipes or information you find online. However, when you claim that you created or invented the recipe or information as your own, you are making unethical choices.

LESSON 8, PART 2

Responsible Programming

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Explain how credit and copyright apply to creative work.
- ✓ Recognize the rights and responsibilities of a creator.

Instructional Activities

- whole-class activity
- whole-class discussion

CSTA Standards

Concept:

- Impacts of Computing
- Algorithms and Programming

Subconcepts and Standards:

- **Culture: 1B-IC-21** Use public domain or creative commons media, and refrain from copying or using material created by others without permission. (P7.3)
- **Program Development: 1B-AP-14** Observe intellectual property rights and give appropriate attribution when creating or remixing programs. (P7.3)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

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attribute **copyright** **creator** **credit**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

intellectual property **license** **piracy** **plagiarize**

Materials and Equipment

Collect or prepare the following:

- computer or tablet with internet access and web browser (per group)
- drawing/sketching materials (per group)
- large whiteboard or anchor chart

Advance Preparation

- Cue up the login screen for the Mix-n-Mash game. (Note: Each group will need to create its own login. For more information on this, please see the Digital Passport FAQs.) See the Online Resources Guide for links to these items.

  www.coreknowledge.org/cksci-online-resources

- On the whiteboard or anchor chart, write the word "Creator."

The Core Lesson

1. Focus attention on today's topic.

Tell students that today they are going to learn about the rights and responsibilities of being a creator. **Ask students:** What does the word *creator* mean when talking about computer devices? Invite students to share their responses, and record their responses on the whiteboard or anchor chart. Explain that a creator is someone who creates something, such as a photo, a song, a piece of writing, or even a program. (See **Know the Standards** 1 and 2.)

Know the Standards

1. 1B-IC-21 Society, Law, and Ethics Ethical complications arise from the opportunities provided by computing. Online piracy, the illegal copying of materials, is facilitated by the ability to make identical-quality copies of digital media with little effort. Other topics related to copyright are plagiarism, fair use, and properly citing online sources. Knowledge of specific copyright laws is not an expectation at this level.

2. 1B-AP-14 Program Development Intellectual property rights can vary by country, but copyright laws give the creator of a work a set of rights that prevents others from copying the work and using it in ways that the creator may not like. Students should identify whether ideas were borrowed and credit the original creator. Students should also consider common licenses that place limitations or restrictions on the use of computational artifacts, such as images and music downloaded from the internet. At this stage, attribution should be written in the format required by the teacher and should always be included on any programs shared online.

Ask students: How do you let someone know that something you created is yours? Help students understand that creators give themselves credit by including their name and sometimes the date they produced the work. Credit is showing in writing that someone has created a work. Write the definition of *credit* on the board, under the definition of *creator*. Tell students that when they give credit to someone else for their work, they are attributing the work to a particular person.

Lead a discussion as to why you would want others to know that a work is yours. Encourage students to think about how they would feel if someone else shared their work and pretended it was theirs or even made money off work they didn't create. Explain that when we create something, it is automatically ours and that there is a law called copyright that says that only creators have the right to say what others can do with their work. There is a special symbol used to indicate a work that is copyrighted. It is a circle with a "c" inside: ©. Write the definition of *copyright* along with the copyright symbol on the board. Ask students if anyone has seen this symbol before and, if so, where.

2. Facilitate the activity.

Device-Based Activity

Place students into small groups, and provide each student access to a computer or tablet. Tell students that they are going to play a game that allows them to remix or mash up pictures and music by other people to create their own work. Have students start a new game by selecting the "Start New Game" button.

> **SUPPORT**—A Spanish language version of the game can be selected using the Language option on the login page.
>
> **SUPPORT**—To support students that may need audio, keyboard controls, a screen reader, or slow motion, demonstrate how to select the appropriate accessibility options for the game after they log in.

Invite students to log in to Digital Passport using a username decided on by the group. Suggest that students take turns, with each creating a least one of the five mash-up scenes. (Note: Instructions for using the game can be accessed using the "?" button.) Special effects can be added on the title screen to add transitions between the scenes. Have the students preview their mash-up before they publish it.

3. Check for understanding.

Online Resources

Have groups present their mash-ups to the class. **Ask students:** How did you attribute the different work you used in the mashup? (by including the author and title of each piece) Why is it important to give credit to others? (Creators should be able to decide how their work is used. Plus, it is illegal to use someone's work without giving credit.)

Device-Based Activity

(Adapted from the Mix-n-Mash module of the Digital Passport Educator Guide)

LESSON 8, PART 3

Making Apps Usable for the Most People

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Improve the accessibility of a design.

Instructional Activities

- whole-class activity
- whole-class discussion

CSTA Standards

Concept: Impacts of Computing

Subconcepts and Standards:

- **Culture: 1B-IC-19** Brainstorm ways to improve the accessibility and usability of technology products for the diverse needs and wants of users. (P1.2)
- **Social Interactions: 1B-IC-20** Seek diverse perspectives for the purpose of improving computational artifacts. (P1.1)

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accessible **app** **diverse** **usability**

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auditory **mobility** **speech** **visual**

Materials and Equipment

Collect or prepare the following:

- teacher-created character cards representing diverse disabilities (1 per group)
- drawing materials (per group)

Advance Preparation

- Prepare character cards by creating several individual characters that have an auditory, visual, mobility, or speech disability. The characters can either be real people or fantasy characters. See the Online Resource Guide for a link to an excellent source of information about these disabilities along with examples.

  www.coreknowledge.org/cksci-online-resources

- On the front of a large index card, give the character a name and provide a short description of the character that includes the type of app the character likes to use and the character's disability (For example, Tony is a nine-year-old boy who loves gaming. He is color blind and cannot tell the difference between red and green colors.) On the back, write one or two possible hardships this character may encounter, such as games that use only green and red to indicate starting and stopping or to distinguish between two players' pieces.
- To learn more about how different disabilities may affect a user's experience with an app, review Mark Brown's videos on "Designing for Disability." See the Online Resource Guide for a link to this item.
  www.coreknowledge.org/cksci-online-resources

The Core Lesson

1. Focus attention on today's topic.

Ask students to raise their hand if they have ever used an app on a smartphone or tablet. Explain that the word app is short for "application." Applications are programs that allow us to do different types of things. Lead a discussion about the different types of apps that students may have used or seen used, such as game apps, photo apps, map apps, browser apps, music apps, video apps, etc.

Tell students that sometimes apps that work for some people don't always work for other people, particularly people who have disabilities. For instance, a music app that doesn't show the lyrics of a song might not work well for someone who cannot hear. App developers need to consider how they will make their programs accessible to people with disabilities. (See **Know the Standards** 1.)

> **SUPPORT**—If one or more of your students has a disability and feels comfortable discussing it with the class, you might encourage that student (or students) to tell the others some of the issues they encounter using popular apps or software.

2. Facilitate the activity.

Unplugged Activity

Tell students that today they are going to act as app designers and think of ways to add or change features to an app that will help someone with a disability. Place students into small groups, and assign each group a character. Students should read the character card and identify which type of app the character likes to use. With this information, they should brainstorm the different possible ways that type of app could be adjusted for the character based on their disability. (See **Know the Standards** 2.)

> **SUPPORT**—If students have difficulties recognizing how a character's disability affects their app use, suggest that students review the barriers listed on the back of the card.

Students should then draw, sketch, or write out their ideas on how to make the app more accessible for their particular character. Suggest that they draw sample screens to illustrate how the feature could be incorporated into an app.

Know the Standards

1. 1B-IC-19 Culture The development and modification of computing technology are driven by people's needs and wants and can affect groups differently. Anticipating the needs and wants of diverse end users requires students to purposefully consider potential perspectives of users with different backgrounds, ability levels, points of view, and disabilities. For example, students may consider using both speech and text when they wish to convey information in a game. They may also wish to vary the types of programs they create, knowing that not everyone shares their own tastes.

1. 1B-IC-20 Social Interactions Computing provides the possibility for collaboration and sharing of ideas and allows the benefit of diverse perspectives. For example, students could seek feedback from other groups in their class or students at another grade level. Or, with guidance from their teacher, they could use videoconferencing tools or other online collaborative spaces, such as blogs or website comments, to gather feedback from individuals and groups about programming projects.

3. Check for understanding.

Unplugged Activity

Have groups present their character and the ideas they devised to improve the character's app experience. **Ask students** How does your app design address the need(s) of your character?

Discuss real-world examples of how apps and other technology can be made more accessible. **Ask students** Are there any operations you struggle with when using an app that could be made easier by the app being made more accessible? How can making something more accessible also make it better for others?

Device-Based Activity

EXTEND—If time permits, have students research Universal Design and how it is useful for the intended group as well as others.

(Adapted from https://studio.code.org/s/courseb-2022/lessons/10)

LESSON 9, PART 1

Computer Technology over Time

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Identify ways in which technology has changed over time.

Instructional Activities

- student reading
- whole-class discussion

CSTA Standards

Concept:

- Impacts of Computing
- Algorithms and Programming

Subconcepts and Standards:

- **Culture: 1A-1C-16** Compare how people live and work before and after the implementation or adoption of new computing technology. (P7.0)
- **Culture: 1B-1C-18** Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by cultural practices.
- **Program Development: 1B-AP-17** Describe choices made during program development using code comments, presentations, and demonstrations. (P7.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

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culture **impact** **influence** **society**

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whisk **barcode**

Instructional Resource

Student Reader

Ch. 9

Student Reader, Chapter 9
Computer Technology over Time

Materials and Equipment

Collect or prepare the following:

- internet access and the means to project images/video for whole-class viewing

The Core Lesson

1. Focus attention on today's topic.

Begin by having students imagine themselves shopping for a new toy at a toy store. Tell them they've selected a classic board game. Tell students when this board game first came out, the cashier might have had to use pen and paper to determine the cost. Some years later, they might have had to type in the price and tell you the cost. Ask students, What does checking out of a store with your new game look like now? Guide and prompt students as needed to have them recognize that now the computer computes the total at the push of a button or a scan of a barcode.

2. Read and discuss "Computer Technology over Time."

Student Reader

Ch. 9

Read together or have students read independently "Computer Technology over Time," in the Student Reader. The selection introduces the idea that things change over time by asking students in Lin's class to bring old and new tools.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 34–35

How have whisks improved over time?

» The whisks went from being hand-tools to working by electricity and finally to working on their own as a counter mixer.

Pages 36–37

How have word processing tools improved over time?

» Previously, you would have to type letters directly onto a piece of paper, and if you made a mistake, you would usually have to start the whole process over again.

Describe the different ways Mr. Vasco's dad wrote, saved, and printed documents on a computer.

» At first, his dad used a typewriter where he could type over mistakes. Later, he was able to use a computer in a computer lab and print Some time later, he used a clunky desktop tower and saved documents to a floppy disk so he could print on other computers.

3. Check for understanding.

Unplugged Activity

This chapter emphasizes word processing, but help students recognize that computer technology has evolved in many ways. Ask students, Can you think of other ways computer technology has changed over time? Engage and prompt students as necessary to address the improvements that have been made to technology. (You may help guide students by discussing telephones, for example.)

SUPPORT—In this lesson, you may want to include a few photos or descriptions that show the progress of computers and word processors.

Device-Based Activity

EXTEND—Offer students the opportunity to research and explore more about the ways computers have evolved over time. Then have them create a timeline that depicts the way computers have changed over time.

LESSON 9, PART 2

Computers and How We Live

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objectives

- ✓ Create and interpret a timeline.
- ✓ Recognize that current computing technology has increased the amount and speed of information that can be accessed and/or shared.

Instructional Activities

- whole-class activity
- student investigation
- whole-class discussion

CSTA Standards

Concept: Impacts of Computing

Subconcept and Standard: Culture: 1B-IC-18 Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by, cultural practices. (P7.1)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

A Glossary at the end of this Teacher Guide lists definitions for Core Vocabulary and selected Language of Instruction.

Core Vocabulary terms are those that students should learn to use accurately in discussion. During instruction, expose students repeatedly to these terms but not through isolated drill or memorization.

technology **timeline**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

decade **DVD** **landline** **rotary phone** **VCR**

Materials and Equipment

Collect or prepare the following:

- butcher paper or construction paper to assemble collage (one piece per group)
- old magazines and/or access to printer for printing images
- yardstick (1 per group)
- ruler (1 per group)
- scissors (1 per group)
- glue sticks (1 per group)
- markers (per group)
- writing paper and pencils (per group)
- computer with internet access
- large TV monitor or projector with display cables (such as HDMI, USB-C, or DisplayPort)
- large whiteboard or anchor chart

Advance Preparation

- Set up a computer and second monitor or projector so that the computer desktop is duplicated (mirrored) on the second screen.
- Cue up PBS's Technology Over Time interactive timelines. See the Online Resources Guide for a link to this item.

  www.coreknowledge.org/cksci-online-resources
- Gather the materials for making a timeline collage.

The Core Lesson

1. Focus attention on today's topic.

Begin the lesson by asking students to identify some of the technology in the classroom. Engage students in a teacher-led discussion. Explain that technology has changed what we do on a daily or almost daily basis, such as communicating with others, watching movies, listening to music, playing games, and traveling. Point out that the technology we use now was not always the same as it is today. On the whiteboard or anchor chart, list several examples of activities and how the technology for doing that activity has changed. Your chart may resemble the following:

Watching movies	Movie theaters, VCR, DVD	Streaming video
Photos	Film camera	Digital camera, smartphones
Written communication	Mailed letters, telegram	Text, chat, social media
Phones	Landline rotary phones, landline pushbutton phones	Cell phones, smartphones
Navigation	Compass, paper maps	GPS navigation

Device-Based Activity

Online Resources

Prompt students to come up with their own examples, and record their responses on the board.

Tell students that people have developed a method for picturing or seeing time, called a timeline. A timeline gives a picture of events during a period of time. Project the Technology Over Time website, and explore the timeline with your students. **Ask:** Have you ever seen or used any of the older items described in the timeline? How are they different from newer versions?

2. Facilitate the activity.

Online Resources

Tell students that today they will be choosing one type of technology and research how it changed over time in order to create a timeline.

> **SUPPORT**—To prevent groups from choosing the same one or two technologies, you may wish to assign a specific technology to each group.

Device-Based Activity

Place students into small groups, and ask them to choose one technology to research. Allow time for students to use computers and/or the library to research their technology. Have them consider the following questions as they work: What is the name of the technology? When was it first invented? Who used this type of technology? Do we still use it today? How is it different from when it was originally invented?

After the research phase is completed, distribute the collage materials. Demonstrate to students how to draw a straight line across the paper to represent time. Tell students that they should organize their timelines by year or decade and include a label with the date, a title, and some descriptive text describing the technology at that time. Encourage students to include images from old magazines or printed images to make the timeline more visually appealing.

3. Check for understanding.

Unplugged Activity

Device-Based Activity

Have groups present their completed timelines to the class and discuss the events shown. **Ask:** How is technology changing the way we live? Do you think technology is making our lives easier or harder? Why?

> **EXTEND**—Have students create a slideshow showing the change in their selected technology over time.

LESSON 10, PART 1

Computer Technology Solves Problems

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Recognize both the positive and negative impacts of technology on society.

Instructional Activities

- student reading
- whole-class discussion

CSTA Standards

Concepts:

- Impacts of Computing
- Algorithms and Programming

Subconcepts and Standards:

- **Culture: 1A-IC-16** Compare how people live and work before and after the implementation or adopting of new computing technology. (P7.0)
- **Culture: 1B-1C-18** Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by cultural practices. (P7.1)
- **Program Development: 1B-AP-17** Describe choices made during program development using code comments, presentations, and demonstrations. (P7.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

A Glossary at the end of this Teacher Guide lists definitions for Core Vocabulary and selected Language of Instruction.

Core Vocabulary terms are those that students should learn to use accurately in discussion and in written responses. During instruction, expose students repeatedly to these terms but not through isolated drill or memorization.

culture **impact** **influence** **society**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

booth **conference**

Instructional Resource

Student Reader

Ch. 10

Student Reader, Chapter 10
Computer Technology Solves Problems

Materials and Equipment

Collect or prepare the following:

- internet access and the means to project images/video for whole-class viewing
- index cards for student vocabulary deck (3 per student)

The Core Lesson

1. Focus attention on today's topic.

Discuss with students that some things they in their homes today are not the same as what adults had in their homes when they were children. Why is that so? Guide students in a discussion that allows them to discuss how technology has advanced significantly over time.

2. Read and discuss "Computer Technology Solves Problems."

Student Reader

Ch. 10

Read together or have students read independently "Computer Technology Solves Problems," in the Student Reader. The selection introduces the idea that the internet is an example of technology that has changed the world.

Guided Reading Supports

When reading aloud together as a class, always prompt students to follow along. Pause for discussion. Include suggested questions and prompts:

Pages 38–39

Explain the benefits or advantages of using videoconferencing and streaming.

» The concept of videoconferencing allows people to connect with one another without needing to be near each other to do so. Streaming also allows people to have access to content anywhere they go.

Page 40

How has Bluetooth technology changed the way computers connect to devices?

» Computers and devices used to require wires and cords in order to connect to one another. However, Bluetooth now allows people to connect to devices without these cords. People can even use their voices to control their devices.

Page 41

Why are drones useful tools?

» Drones can allow people access to photos or images over areas that they might not be able to get to.

3. Check for understanding.

Unplugged Activity

Ask students to reflect on what they read in this chapter. Guide them through a discussion of summarizing how the technology Lin saw at the fair impacted Lin's world. Now instruct students to draw and/or write while responding to the question In what ways has technology helped your own life? Remind students to think about how their world would be different if they didn't have a voice assistant device, for example. How would it impact them? Allow them to write or create and, if time permits, share their work.

Device-Based Activity

EXTEND—Offer students the opportunity to select one of the technologies listed in the chapter to explore more about the history of it. For example, you may have students research the evolution of Bluetooth technology. They may then present their findings in a slideshow to show how the technology began and how it grew into what it is today.

LESSON 10, PART 2

Explaining a Design

Driving Question: What kinds of problems can we solve with computers?

Overarching Unit Objective: Model solution design in increasing complexity and involving conditionals and loops.

At a Glance

Learning Objective

✓ Explain and elaborate on choices made in a design process.

Instructional Activities

- student investigation
- whole-class discussion

CSTA Standards

Concept: Algorithms and Programming

Subconcept and Standard: **Program Development: 1B-AP-17** Describe choices made during program development using code comments, presentations, and demonstrations. (P7.2)

For detailed information about the CSTA Standards, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Core Vocabulary and Language of Instruction

A Glossary at the end of this Teacher Guide lists definitions for Core Vocabulary and selected Language of Instruction.

Core Vocabulary terms are those that students should learn to use accurately in discussion. During instruction, expose students repeatedly to these terms but not through isolated drill or memorization.

code comments **explanation** **program developer**

Language of Instruction consists of additional terms that you should use when talking about concepts in the lesson. Students benefit from your modeling the use of these words without the expectation that students will use or explain the words themselves.

app **design** **revise** **text**

Materials and Equipment

Collect or prepare the following:

- game design projects from Lessons 6.3 and 6.4
- drawing paper
- drawing/sketching materials (per group)
- sticky notes
- large whiteboard or anchor chart

Advance Preparation

- Gather the group game designs from Lessons 6.3 and 6.4.
- Gather the character cards from Lesson 8.3.

The Core Lesson

1. Focus attention on today's topic.

Explain to students that when programmers write code, they are writing in a language that a computer can understand. But sometimes they need to explain what they are doing in the code so that other people looking at the code can understand it. When programmers add text explanations in their code, the explanations are called code comments. (See **Know the Standards**.)

Online Resources

SUPPORT—To help support visual learners, you could project examples of actual code comments for the class. For sample comment images, see the Scratch Wiki Comment page. See the Online Resources Guide for a link to this item.

www.coreknowledge.org/cksci-online-resources

Ask students What are some other ways in which program developers might communicate the choices they make while designing a program? Help students understand that some program developers might use reports, presentations, or demonstrations to share their explanations.

Know the Standards

1. 1B-AP-17 Program Development People communicate about their code to help others understand and use their programs. Another purpose of communicating one's design choices is to show an understanding of one's work. These explanations could manifest themselves as in-line code comments for collaborators and assessors or as part of a summative presentation, such as a code walk-through or coding journal.

2. Facilitate the activity.

Unplugged Activity

Re-form the groups from Lessons 6.3 and 6.4, and provide students with their game design projects from Lessons 6.3 and 6.4. Have students review their original materials. **Ask:** What do you remember about the choices you made for this project? What were the reasons for those choices?

Tell students that today they are going to provide explanations about their design choices/reasoning to the rest of the class.

Provide groups with their original game design to lay out on a desk or table. Groups should reflect upon the choices they made to improve upon the existing design. Tell them to use a single color of sticky notes to write or draw some of the details about their game design choices from Lesson 6.3, as well as the element they chose to modify in Lesson 6.4. They should stick these comments to the appropriate place on the game board.

As a group, they should then brainstorm different ways they could modify their game for someone with a disability. (Pull out the character cards from Lesson 8.3.) They should use a different color sticky note to draw, sketch, or write their comments about how they would make the game more accessible for a particular character.

Time permitting, groups can select a different character card and a different color sticky note to comment on design modifications they would make for the new character.

3. Check for understanding.

Unplugged Activity

Have groups do a gallery walk around the room to view each other's games and comments that depict the ways each group would improve their design to become more accessible.

Time permitting, ask students to present their games to the class, sharing their original design and then explaining the changes they would make to improve it and make it accessible to as many people as possible.

GRADE 4

Teacher Resources

Activity Pages

Name _____ Date _____

Activity Page 2.2

Use with Lesson 2, Part 2

Message Data Packets

Packet 1 Header: 1 _____ Data	Packet 1 Header: 2 _____ Data	Packet 1 Header: 3 _____ Data	Packet 1 Header: 4 _____ Data	Packet 1 Header: 5 _____ Data	Packet 1 Header: 6 _____ Data	Packet 1 Header: 7 _____ Data	Packet 1 Header: 8 _____ Data	Packet 1 Header: 9 _____ Data	Packet 1 Header: 10 _____ Data
Packet 2 Header: 1 _____ Data	Packet 2 Header: 2 _____ Data	Packet 2 Header: 3 _____ Data	Packet 2 Header: 4 _____ Data	Packet 2 Header: 5 _____ Data	Packet 2 Header: 6 _____ Data	Packet 2 Header: 7 _____ Data	Packet 2 Header: 8 _____ Data	Packet 2 Header: 9 _____ Data	Packet 2 Header: 10 _____ Data
Packet 3 Header: 1 _____ Data	Packet 3 Header: 2 _____ Data	Packet 3 Header: 3 _____ Data	Packet 3 Header: 4 _____ Data	Packet 3 Header: 5 _____ Data	Packet 3 Header: 6 _____ Data	Packet 3 Header: 7 _____ Data	Packet 3 Header: 8 _____ Data	Packet 3 Header: 9 _____ Data	Packet 3 Header: 10 _____ Data

Appendix A

Glossary

Orange words and phrases are Core Vocabulary terms for the unit. **Bold-faced words and phrases** are additional vocabulary terms related to the unit that you should model for students during instruction and that are often used within the Student Reader, and these latter terms do not have specific page numbers listed. Vocabulary words are not intended for use in isolated drill or memorization.

A

accessible, adj. how easy something is to understand or use

action, n. a movement or thing to do

algorithm, n. steps or rules to follow to complete a specific task or to solve a problem

app, n. abbreviation for *application*; a program that enables a computing device to do certain tasks

attribute, v. to give credit to the maker of a product

auditory, adj. related to hearing

B

ballpoint, adj. a writing implement with a ball in its tip that leaves a line of ink when it rolls across paper

barcode, n. an arrangement of black bars printed on objects to identify them

bug, n. an error that causes a computer program to work incorrectly

C

categorize, v. to organize things into groups that have something in common

cause, n. the reason that something happens

code, n. instructions for a computer device to complete a task

code comments, n. details and ideas regarding design choices

collaboration, n. working together as a team

communicate, v. to share information

compare, v. to note the similarities of two things

component, n. a part of a greater whole

conditional, adj. dependent on a certain factors

control, v. to command or manage

copyright, n. legal protection for the creator of original content

crash, v. a computer program stops working correctly

creator, n. someone who creates something original

credit, n. acknowledgement for having done something favorable

cube, n. a solid shape with all square sides

culture, n. the traditions, beliefs, and behaviors of a group of people

D

data, n. details of information collected by observation or measurement

data table, n. a diagram that displays data in rows and columns

datum, n. a single piece of data

debug, v. to fix something that is not functioning properly in a computer program

decade, n. ten years

decompose, v. to break down into smaller tasks

decomposition, n. the process of breaking something into parts

design, v. to plan out

development, n. the act of making or improving something

diverse, adj. differing

DVD, n. digital video disc; a storage device for digital data that can be deciphered by certain computer devices

E

equitable, adj. fair

effect, n. the result of a cause

ethics, n. a set of values for guiding people to differentiate between right and wrong actions

external, adj. outside of

event, n. part of a program that runs in response to certain actions

evidence, n. information that helps prove something

explanation, n. a description of the reasons for an outcome or condition

F

font, n. the style of text

fundraiser, n. a set of activities that people do to collect money to support something helpful

H

header, n. the portion of a message that shows the IP addresses and the individual number of each packet

I

icon, n. a small picture used to represent something in a way that takes up less space than words

identify, v. to find out or name

identity, n. who a person is; includes their characteristics and how they describe themselves

identify thief, n. someone who illegally pretends to be someone else

if/then statements, n. conditional statements that explain if something is done, then something else will happen

impact, n. effect

incorporate, v. to include as a part of a larger whole

influence, v. to affect an outcome

information, n. collected knowledge

intellectual property, n. original ideas that belong to the person who came up with them

internal, adj. inside of

internet, n. the network of connected computers all over the world

interpret, v. to explain the meaning of something

IP (Internet protocol), n. the way that digital information is sent from one computer to another

IP address, n. a computer network's unique identification on the internet

L

label, n. a term that identifies an object

landline, n. a telephone's access to a communication network that relies on connected wires

license, n. official permission to do something that cannot be done without that permission

loop, n. instructions that repeat

M

mobility, n. the ability to move

modify, v. to change or update

module, n. one part of a series of similar units that are intended to work together

N

network, n. a group of computer devices that communicate with each other

O

online, adj. connected to the internet

organize, v. to arrange in an orderly way

P

packet, n. a small collection contained together

permission, n. approval to act

personal information, n. details that can be used to identify and find an individual

perspective, n. a way of thinking about or understanding an idea; point of view

piracy, n. the use of someone else's property, invention, or idea without compensating them; theft

plagarize, v. to copy someone else's work or idea and claim it as one's own

planning, v. determining the steps and requirements of a task, design, or solution

present, v. to display information to others and tell them about it

private, adj. not public; information only known by some people

private information, n. personal details that individuals should not share publicly

program, n. a set of instructions that tell a computer what to do

program developer, n. a person who designs computer programs

programmer, n. a person who writes computer code

public, adj. accessible by anyone

Q

quantitative, adj. able to be specifically counted or measured

questionnaire, n. a list of questions used to gather information from people participating in a survey

R

rank, v. to put in order

represent, v. to stand for

reset, v. to begin again from an original starting point

revise, v. to change in order to improve

role, n. a part a person plays in a given situation; a job

rotary phone, n. a telephone that connects to a landline and operates with a wheel for the caller to dial numbers to make a call

S

scroll, v. to move words or pictures on a screen by sliding the contents up or down

sequence, n. an order of actions

server, n. a large computer system that stores, sends, and receives data from other computers on a network

society, n. members of a community and their actions as a group

speech, n. communication through talking

sphere, n. a solid in the shape of a ball

strategy, n. a plan for solving a problem

survey, n. a planned collection of information from a target population

system, n. a set of parts that work together to complete a task

T

task, n. a job that needs to be completed

text, n. written or typed words and numbers that are read visually

timeline, n. a diagram that displays the order in which events happened

technology, n. the use of science to solve problems

teamwork, n. working together as a group

testing, n. the process of trying out a design to determine whether it works as intended

trial and error, n. the process of trying different possible solutions to a problem to eliminate the ones that don't work

troubleshoot, v. to identify and correct the problem in a system

U

unique, adj. different from all others

usability, n. the quality of how easy something is to use

V

value, n. a numerical amount

variable, n. a value that can change depending on conditions or input

VCR, n. video cassette recorder; a device that records, stores, and plays back video using small, contained reels of electromagnetic tape

visual, adj. related to the sense of sight

visualize, v. to form a mental picture

Appendix B

Internet Safety

Though online resources present many rich opportunities for student learning, unsupervised online activity for children is not advised. The U.S. Department of Justice provides the following guidelines, Keeping Children Safe Online:

- **Discuss internet safety and develop an online safety plan** with children before they engage in online activity. Establish clear guidelines, teach children to spot red flags, and encourage children to have open communication with you.
- **Supervise young children's use of the internet**, including periodically checking their profiles and posts. Keep electronic devices in open, common areas of the home, and consider setting time limits for their use.
- **Review games, apps, and social media sites** before they are downloaded or used by children. Pay particular attention to apps and sites that feature end-to-end encryption, direct messaging, video chats, file uploads, and user anonymity, which are frequently relied upon by online child predators.
- **Adjust privacy settings and use parental controls** for online games, apps, social media sites, and electronic devices.
- **Tell children to avoid sharing personal information, photos, and videos online** in public forums or with people they do not know in real life. Explain to your children that images posted online will be permanently on the internet.
- **Teach children about body safety and boundaries**, including the importance of saying "no" to inappropriate requests both in the physical world and the virtual world.
- **Be alert to potential signs of abuse**, including changes in children's use of electronic devices, attempts to conceal online activity, withdrawn behavior, angry outbursts, anxiety, and depression.
- **Encourage children to tell a parent, guardian, or other trusted adult** if anyone asks them to engage in sexual activity or other inappropriate behavior.

Copy and distribute the Student Safety Contract, found on the next page. Prior to the start of the first lesson, do a read-along and have students agree to the expectations for when they engage in computer and online activities.

Online Resources

For additional support for safety in the computer science and online instruction, follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

Student Online Safety Contract

Dear Parent or Guardian,

During computer science class, we want to create and maintain a safe classroom. With this in mind, we are making sure students are aware of the expectations for their behavior while engaged in computer science activities. We are asking you to review the safety rules below with your student and sign this contract. If you have any questions, please feel free to contact me.

For important safety information about children, computers, and the internet, consider resources at these sites:

https://protectyoungeyes.com/

https://sharedhope.org/

https://www.justice.gov/coronavirus/keeping-children-safe-online

_____ _____/_____/_____/

Teacher signature and date

_____ _____/_____/_____/

Parent or guardian signature and date

When doing online activities, I will do the following:

- Only do online activities with the supervision of an adult.
- Only visit websites and use apps that I am guided to by my teacher, parent, or trusted adult guardian.
- Never use my real name or reveal personal information if I communicate with others online.
- Tell a trusted adult right away if anyone online asks questions about my name, where I live, where I go to school or asks me to send them a picture of me, of my family, or of my friends.
- Be careful around electronic devices and only plug them in or unplug them when an adult is supervising.

I understand and agree to the safety rules in this contract.

_____ _____/_____/_____/

Student signature and date

_____

Print name

Appendix C

Strategies for Acquiring Materials

The materials used in the Core Knowledge Computer Science program are readily available and can be acquired through both retail and online stores. Some of the materials will be reusable and are meant to be used repeatedly. This includes items such as plastic cups that can be safely used again. Often these materials are durable and will last for more than one activity or even one school year. Other materials are classified as consumable and are not able to be used more than once.

Online Resources

The Material Supply List for this unit's activities can be found online. Follow the links in the Online Resources Guide for this unit:

www.coreknowledge.org/cksci-online-resources

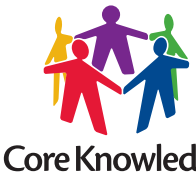
Ways to Engage with Your Community

The total cost of materials and technology can add up for an entire unit, even when the materials required for activities and demonstrations have been selected to be individually affordable. And the time needed to acquire the materials adds up too. Reaching out to your community to help support STEM education is a great way to engage parents, guardians, and others with the teaching of science and computer science, as well as to reduce the cost and time of collecting the materials. With that in mind, the materials list can be distributed or used as a reference for the materials teachers will need to acquire to teach the unit.

Consider some of the following as methods for acquiring the science materials:

- School Supply Drive—If your school has a supply drive at any point in the year, consider distributing materials lists as wish lists for the science department.
- Open Houses—Have materials lists available during open houses. Consider having teams of volunteers perform an activity to show attendees how the materials will be used throughout the year.
- Parent-Teacher Organizations—Reach out to the local PTO for assistance with acquiring materials.
- Science Fair Drive—Consider adding a table to your science fair as part of a science materials drive for future units.
- College or University Service Project—Ask service organizations affiliated with your local higher education institutions to sponsor your program by providing materials.
- Local Businesses—Some businesses have discounts for teachers to purchase school supplies. Others may want to advertise as sponsors for your school/programs. Usually you will be asked for verifiable proof that you are a teacher and/or for examples of how their sponsorship will benefit students.

Remember: If your school is public, it will be tax exempt, so make sure to have a Tax Identification Number (TIN) when purchasing materials. If your school is private, you may need proof of 501(c)(3) status to gain tax exemption. Check with your school for any required documentation.



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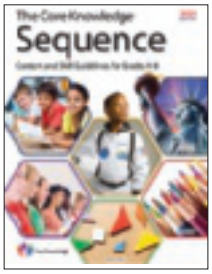
Core Knowledge SCIENCE™

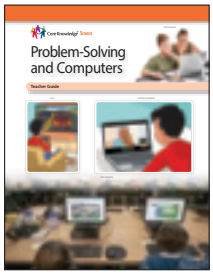
Codes and Computers

Core Knowledge Science 4



What is the Core Knowledge Sequence?

The *Core Knowledge Sequence* is a detailed guide to specific content and skills to be taught in Grades K–8 in language arts, history, geography, mathematics, science, computer science, and the fine arts. In the domain of computer science, the *Core Knowledge Sequence* outlines topics that build systematically grade by grade to support student learning progressions coherently over time.



For which grade levels is this book intended?

In general, the content and presentation are appropriate for students in the upper elementary grades. For teachers and schools following the *Core Knowledge Sequence*, this book is intended for Grade 4 and is part of a series of **Core Knowledge SCIENCE** units of study.

For a complete listing of resources in the **Core Knowledge SCIENCE** series, visit **www.coreknowledge.org**.

CKSci™

Core Knowledge SCIENCE™

A comprehensive program in science, integrating topics
from Earth and Space, Life, and Physical Sciences
with concepts specified in the Core Knowledge Sequence
(content and skill guidelines for Grades K–8)

Core Knowledge SCIENCE™
units at this level include:

Energy Transfer and Transformation
Investigating Waves
Structures and Functions of Living Things
Processes That Shape Earth
Using Natural Resources for Energy
Human Respiration and Circulation
Problem-Solving and Computers

www.coreknowledge.org

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