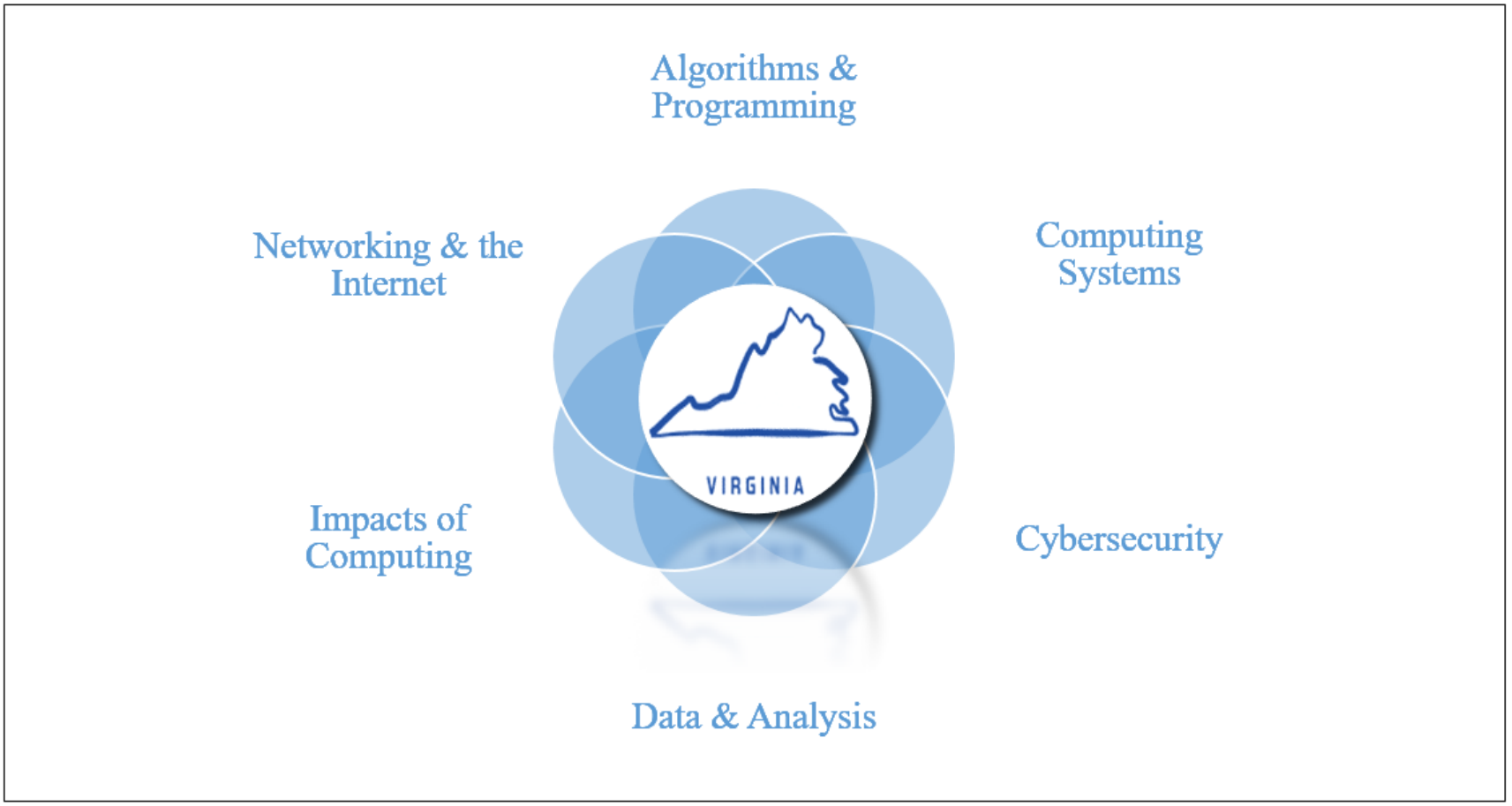
Computer Science Standards of Learning

Curriculum Framework



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The 2017 *Computer Science Curriculum Framework* can be found on the Virginia Department of Education's Web site.

Introduction

The *Computer Science Standards of Learning* Curriculum Framework amplifies the *Computer Science Standards of Learning for Virginia Public Schools* and defines the content knowledge, skills, and understandings that are measured by the Standards of Learning. The Computer Science Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers as they plan their lessons by identifying essential questions and vocabulary to drive instruction and defining the essential skills students should demonstrate. This supplemental framework delineates in greater specificity the minimum content that all teachers should teach and all students should learn.

School divisions should use the *Computer Science Curriculum Framework* as a resource for developing sound curricular and instructional programs. This framework should not limit the scope of instructional programs. Additional knowledge and skills that can enrich instruction and enhance students' understanding of the content identified in the Standards of Learning should be included as part of quality learning experiences.

Each topic in the *Computer Science Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by broadening the context of the standards and identifying essential student skills that should be the focus of instruction for each standard.

Context of the Standard

The Context of the Standard provides educators an explanation of the standard, including a description and the vertical development of the concept. This context will support teachers in incorporating computer science content into discipline-specific lessons. The intention of the Computer Science standards in grades K-8 is that Computer Science principles be integrated throughout content area instruction.

Essential Skills

The Essential Skills define student performance expectations aligned to each standard. The intent of the K-8 computer science standards is that the concepts are integrated into existing disciplines and this will result in these skills being emphasized differently in each content area. The expectation is that these Essential Skills are partnered with content area performance expectations as appropriate in instruction. At the high school level, the expectations in the 2017 *Computer Science Standards of Learning Curriculum Framework* are to be used in the support of standalone computer courses; the essential skills outlined in the document are not intended to be integrated into other coursework unless a teacher chooses to use the content to support discipline practices.

Essential Questions
Each standard has identified key questions to drive classroom instruction. These questions lead teachers and students toward the big ideas of each concept and provide a more holistic viewpoint used to lead instruction relating to the context of each standard.

Essential Vocabulary
In order to effectively communicate Computer Science concepts, essential vocabulary terms are defined in grade-level appropriate terms. These definitions are found in the glossary (Appendix A).

Grade Two

The standards for second grade place an emphasis on creating models of physical objects or processes in order to demonstrate relationships. Second grade standards build on students' skills in constructing programs and utilizing algorithms. The accurate use of terminology as well as the responsible use of technology will continue to be built upon. The foundational understanding of computing and the use of technology will be an integral component of successful acquisition of skills across content areas.

Algorithms and Programming

2.1 The student will construct sets of step-by-step instructions (algorithms) both independently and collaboratively

a. using sequencing;
b. using loops (a wide variety of patterns such as repeating patterns or growing patterns); and
c. identifying events.

Context of the Standard
At school and at home, students engage in step-by-step activities on a routine basis. These may include such activities as brushing their teeth or preparing to leave school at the end of the school day. When students document these step-by-step instructions they are creating algorithms. Sometimes there are repeating steps in a task, and students can create a loop in their algorithm to indicate that repeating pattern. Algorithms can be created with or without computers. In first grade the students are introduced to the use of loops, in second grade this understanding expands to include repeating patterns and growing patterns. In second grade, the construction of loops becomes more complex as students use a wide variety of patterns to include repeating and growing patterns. In a repeating pattern the units of the pattern repeat and remain the same. In a growing pattern, an addition is added to the pattern causing the pattern to change every time it repeats. Growing patterns involve a progression from step to step which make them more difficult for students than repeating patterns. Repeating and growing patterns are foundational in mathematics in the development of algebraic reasoning and in computer science in developing computational thinking. Sample numeric patterns include: 6, 9, 12, 15, 18,....(growing pattern); 1, 2, 4, 7, 11, 16,….(growing pattern); 20, 18, 16, 14,…..(growing pattern); and

Context of the Standard
1, 3, 5, 1, 3, 5, 1, 3, 5,.....(repeating pattern). In second grade, students are also expected to identify events. In computer science, an event is an action or occurrence detected by a program. Events can be user actions, such as clicking a mouse button or pressing a key, or system occurrences, such as a timer or low battery.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Describe the steps taken to accomplish an activity using both sequences and loops. • Identify a section of repeated actions to replace with a loop. • Predict the next step in a looping sequence. • Describe an event that causes the start of a sequence of steps to accomplish a daily task. • Compare and contrast a repeating pattern and a growing pattern.	Students should *investigate* these concepts: • What are examples of tasks where a loop would be appropriate? • What are examples of events in a plugged or an unplugged activity? • What is the difference between a repeating and a growing pattern? • How can repeating and growing patterns be represented in a sequence?	Students should be *introduced* to these concepts: • Loop • Event

2.2 The student will construct programs to accomplish tasks as a means of creative expression using a block-based programming language or unplugged activities, both independently and collaboratively

a. using sequencing;
b. using loops (a wide variety of patterns, such as repeating patterns or growing patterns); and
c. identifying events.

Context of the Standard
When an algorithm or a set of algorithms is tested, a program has been created. People work together to plan, create and test these programs. This process of planning, creating, and testing a program or algorithm is called programming and is used to create a wide variety of products such as video games, interactive art projects and digital stories. In second grade, students are expected to develop simple programs that use both sequencing and simple loops to complete a task. These programs may be developed using block-based or unplugged activities. Block-based programs (e.g., Scratch Jr., Tynker) allow students to develop simple algorithms using a computer. Students are also expected to identify events; an event is an action or occurrence detected by a program.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • As a class and individually, construct a sequence of steps to accomplish an activity. • Recognize that a sequence of steps when using a computer is called a program. • Recognize a repeated sequence of steps as an opportunity to use a loop.	Students should *investigate* these concepts: • How would you write instructions for an action that repeats itself? • What are different ways that you can signal the start of a program: plugged and unplugged? • What does the word “event” mean in the context of programming?	Students should be *introduced* to these concepts: • Event • Loop • Program • Repeat

Essential Skills	Essential Questions	Essential Vocabulary
• Model the steps of a program that contains at least one loop using coding cards or similar instructional strategy. • Identify events that are used in a program. • Explain the role of an event in a program.		

2.3 The student will analyze, correct, and improve (debug) an algorithm that includes sequencing and simple loops, with or without a computing device.

Context of the Standard
The practice of reviewing work should be taught early and can be applied across disciplines, including computer science. Students should check that the sequence of steps that compose an algorithm works as intended. That is the only way to determine if the algorithm appropriately reflects the steps that must occur to complete a task. This process can be conducted for both computer programs and unplugged activities. If the algorithm does not work as intended, the students should determine the changes to make in the algorithm in order to complete the task. These changes may include adding, deleting, rearranging, or changing a step in order to obtain the intended outcome. The process of revising a program so that it works as intended is called debugging.

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills:	Students should *investigate* these concepts: • How do you identify an error in a set of instructions?	Students should be *introduced* to these concepts: • Debug

Essential Skills	Essential Questions	Essential Vocabulary
• Understand that a sequence and/or program may not always work correctly. • Describe how an algorithm did not work (e.g., character is not moving as intended). • Analyze a simple sequence of steps that is flawed and determine possible solutions. • As a class, implement a proposed adjustment to a sequence that did not work as intended.	• Once you have found an error in your instructions, how do you decide what adjustment needs to be made to the sequence? • How can you accomplish a goal with fewer steps?	

2.4 The student will plan and create a design document to illustrate thoughts, ideas, and stories in a sequential (step-by-step) manner (e.g., story map, storyboard, sequential graphic organizer).

Context of the Standard
As students write and tell stories, they use tools such as story maps, storyboards, and sequential graphic organizers to plan and describe events. In second grade, planning stories becomes more complex as they begin to add descriptive details to their stories. Planning a story is similar to writing an algorithm or program in that there are steps that are followed as the author determines the beginning, middle and end of the story as well as adds details to accomplish a task. Just as there are multiple ways to tell a story, different algorithms can be used to describe a task. While the end results may be similar, the actual pathway to achieve the task may not be the same. This standard is intended to develop a fundamental understanding that programs can be developed using similar strategies as stories.

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills: • Plan and create a design document to tell a story. • Using a graphical representation (graphic organizer, storyboard, or story map), retell a story by arranging the events in the correct sequence. • Participate in teacher-directed planning and writing strategies to organize ideas and information into a story and/or program.	Students should *investigate* these concepts: • How is a program like a story? • What are ways that you plan and write a story and/or program? • How can you identify the beginning, middle, and end of a story?	Students should be *introduced* to these concepts: • Storyboard • Graphic organizer

2.5 The student will compare and contrast a group of items based on the attributes or actions of each item, with or without a computing device.

Context of the Standard
Objects and actions have attributes; these attributes allow people to group items. Attributes may be physical properties, behaviors, or actions. Actions in computer science are reflected in step-by-step sequences (algorithms). Actions may include back and forth movement, turning, and stopping. Categorizing of attributes or actions relies on careful observation of patterns and similarities and differences. In this standard, students are expected to analyze groups of items and compare and contrast the attributes that led to the development of the group. In block-based programming environments, commands are grouped into categories based on function. In higher level programming languages, data are often classified by the type and format of the information.

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills: • Sort and group (classify) objects into appropriate groups (categories) based on multiple attributes. • Label attributes of a set of objects that has been sorted. • Name multiple ways to sort a set of objects.	Students should *investigate* these concepts: • How are items organized with multiple attributes? • Why is it useful to sort objects into groups? • Why is sorting objects into groups helpful in our daily lives?	Students should be *introduced* to these concepts: • Attribute

2.6 The student will acknowledge that materials are created by others (e.g., author, illustrator, and website).

Context of the Standard
As students start to work with different artifacts (reference materials, resources, etc.) they should understand that these sources of information were created by others. Authors, illustrators, and programmers are responsible for the creation of many sources of information that are used in the classroom and at home. This standard begins an exploration of the concepts of intellectual property laws and plagiarism. *Students are not responsible for the terms property laws and plagiarism in second grade.*

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills: • Explain that artifacts have owners.	Students should *investigate* these concepts:	Students should be *introduced* to these concepts:

Essential Skills	Essential Questions	Essential Vocabulary
• State whether an artifact is created by the student or someone else. • Identify when to credit others work when using their resources. • Identify authors as needed in class projects (individually and as a class) either in writing or orally.	• How can you find the author of a website or book? • What is the difference between creating something on your own and changing someone else's work? • How can you give credit when you are using other people's ideas/work?	• Author • Digital Artifact • Illustrator • Website

Computing Systems

2.7 The student will describe the characteristics of computing systems to include hardware, software, input, and output.

Context of the Standard
A system is defined as a regularly interacting or interdependent group of items forming a unified whole. A computing system is composed of hardware and software. Hardware consists of physical components, while software provides instructions for the system. These instructions are represented in a form that a computer can understand and allow the user to input information and, once the task is completed, obtain output in a form that can be understood. Hardware and software work together as a system to accomplish tasks, such as sending, receiving, processing, and storing units of information. Hardware devices include screens to display information and buttons, keys, or touch screens to enter information. Software applications are programs with specific purposes, such as a web browser or game. A person may use a mouse (hardware) to click on a button displayed in a web browser (software) to navigate to a new web page.

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills: • Compare and contrast hardware and software. • Describe how both hardware and software are used in a computing system. • Identify the input and output associated with a given task.	Students should *investigate* these concepts: • What are the differences between hardware and software? • What are examples of hardware and software? • What are examples of input and output? • If you were a computer, what would be an example of input and output?	Students should be *introduced* to these concepts: • Hardware • Software • Input • Output

2.8 The student will identify, using accurate terminology, simple hardware and software problems that may occur during use (e.g., app or program not working as expected, no sound, device won't turn on).

Context of the Standard
Although computing systems may vary, common troubleshooting strategies can be used on them, such as checking connections and power or swapping a working part in place of a potentially defective part. Rebooting a machine is commonly effective because it resets the computer. Since computing devices are composed of an interconnected system of hardware and software, troubleshooting strategies may need to address both. Students in second grade are expected to use accurate terminology to describe simple problems with computer hardware and software.

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills:	Students should *investigate* these concepts:	Students should be *introduced* to these concepts:

Essential Skills	Essential Questions	Essential Vocabulary
• Identify when a device or program is not working properly. • Communicate that a device or program is not working. • Perform simple troubleshooting tasks (e.g., rebooting the computer).	• How can you tell a computer is not working as intended? • What is the first thing you should try if a program is not working? • Why is it important to be as specific as possible when you are describing a problem?	• Reboot • Troubleshoot

Cybersecurity

2.9 The student will explain what is allowed and what is not allowed at school associated with the use of technology (e.g., class rules).

Context of the Standard
Computer networks, including the Internet, can be used to connect people to other people, places, information, and ideas. In order to keep students safe, schools and divisions have rules on the appropriate use of technology. All students should be aware of what is allowed and not allowed when using division/school technology. Appropriate use of technology as well as school and division rules when using technology should be reviewed with students on a regular basis. Consistent monitoring of students when engaged with technology should be conducted at all times.

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills: • Classify computer actions as allowed or not allowed based on school rules. • Communicate the process for reporting inappropriate use of technology. • Demonstrate proper care for electronic devices (e.g., handling, logging off or shutting down correctly, and keeping devices away from water/food).	Students should *investigate* these concepts: • What is appropriate use of technology in school? • If you see someone using technology inappropriately in school, how should you notify the proper person?	Students should be *introduced* to these concepts:

2.10 The student will identify and create strong passwords, explain why strong passwords should be used. (e.g., protect name, address, and telephone number).

Context of the Standard
Connecting devices to a network or the Internet provides great benefit, but care must be taken to protect private information such as a student's name, phone number, and address. Passwords are used to protect devices and information from unauthorized access. Because computer programs can be used to guess passwords, strong passwords have characteristics that make them more difficult to guess. Many sites have rules as to the length and composition of passwords; these rules help create stronger passwords. The practice of not sharing passwords should be emphasized in the classroom and at home. At the elementary level, students are encouraged to use passwords. These passwords may not be as complex as those used by adults in protecting information. Suggestions for creating strong passwords for students include: 1. Use uppercase and lowercase letters. 2. Use numbers.

Context of the Standard
3. Use symbols. 4. Use at least 8 characters. 5. Don't use words from a dictionary. 6. Don't use the same password twice. 7. Don't use personal information. *Students are not expected to list these suggestions; however, these suggestions may be introduced when students are allowed to create or classify passwords.*

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Explain how a password helps protect the privacy of information. • Refrain from using other students' password. • Explain how logging off devices can protect your information. • Classify passwords as strong or weak.	Students should *investigate* these concepts: • What are the components of a strong password? • Why are strong passwords needed when using a computer?	Students should be *introduced* to these concepts: • Password

Data and Analysis

2.11 The student will construct and analyze data and organize it in a chart or graph in order to make a prediction, with or without a computing device.

Context of the Standard
The collection and use of data about individuals and the world around them is a routine part of life and influences how people live. Data are pieces of information collected about people or things. These data can be recorded in tables and can be used to construct pictographs or bar graphs. Everyday digital devices can be used to collect and display data over time. Examples include cell phones, digital toys, and cars. These can contain tools (such as sensors) and computers to collect and display data from their surroundings. Once data has been collected and organized into a chart or graph, it can be analyzed to determine if a pattern exists. The pattern can be used to make predictions or answer questions.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Represent gathered data in tables (vertically or horizontally). • Represent data using pictographs or bar graphs.	Students should *investigate* these concepts: • What are examples of data that we can collect in the classroom or schoolyard? • What are different ways to display data? • What are the steps involved in collecting, arranging, and displaying data?	Students should be *introduced* to these concepts: • Data • Prediction

2.12 The student will create a model of a physical object or process in order to show relationships with or without a computing device (e.g., water cycle, butterfly life cycle, seasonal weather patterns).

Context of the Standard
Scientists, computer scientists, mathematicians, and programmers construct and use models to better conceptualize and understand phenomena under investigation or to develop a possible solution to a proposed problem. Models include diagrams, physical replicas, mathematical representations, analogies, and computer simulations. Models are used to represent a system (or parts of a system) under study, to aid in the development of questions and explanations, to generate data that can be used to make predictions, and to communicate ideas to others. In second grade, students are expected to create simple models. These models may be created using a computing device.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Create a model of an object or process both individually and as a class. • Compare and contrast attributes of a model.	Students should *investigate* these concepts: • What are examples of models that we see and use regularly? • What are examples of things in the world that you can model? • What kinds of things do you need to know before you begin to make a model?	Students should be *introduced* to these concepts: • Model

Impacts of Computing

2.13 The student will compare and contrast examples of how computing technology has changed and improved the way people live, work, and interact.

Context of the Standard
People have always used devices to assist in computation. They can help in the collection, storage, or manipulation of data. Early computers used mechanical components to perform calculations. In the early 1800s, the first programmable computers were created. They were limited in their capability, and relied heavily on people to do more complex computation. These people were referred to as computors due to their similar role. Many of these computors were women who were employed in commerce, government, military, and research establishments. The development of computing technology has expanded exponentially over the past 100 years. The development and modification of computing technology is driven by people's needs and wants. Computing technologies influence, and are influenced by, cultural practices.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Identify different types of technologies that people use in their daily lives. • Explain tasks that are made easier because of computing technology.	Students should *investigate* these concepts: • What do you think is the earliest example of a computer? • How do computers affect your daily life? • How do computers make certain tasks easier? • What would your life be like without computing devices?	Students should be *introduced* to these concepts:

2.14 The student will identify and model responsible behaviors when using information and technology.

Context of the Standard
Responsible behavior should always be used when working with computers, such as not sharing login information, keeping passwords private, and logging off when finished. These behaviors apply regardless of whether a student is at school or on a computer at another location. In addition to keeping information private, responsible behaviors should be exhibited when engaging in online communications. Online communication facilitates positive interactions, such as sharing ideas with many people, but the public and anonymous nature of online communication also allows for intimidating and inappropriate behavior in the form of cyberbullying. Cyberbullying is a form of bullying that occurs when online communications are sent that are intimidating or threatening in nature.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Interact responsibly with peers when using technology. • Describe what information should be shared and not shared. • Describe online behaviors that may be harmful to others. • Practice responsible behaviors at all times when using computers.	Students should *investigate* these concepts: • What are examples of responsible online behavior? • What information is acceptable to share online? • What are behaviors that should be avoided when interacting with others online? • What should you do if a person sends you information that is intimidating, threatening, or that makes you feel badly? • What should you do if a friend is being bullied or cyberbullied?	Students should be *introduced* to these concepts: • Cyberbullying

Networking and the Internet

2.15 The students will discuss with partners and as a class how information can be communicated electronically (e.g., email, social media, video conferencing, blogging).

Context of the Standard
Online communication facilitates positive interactions, such as sharing ideas with many people, including friends and family around the world. It also allows opportunities for scientists, mathematicians, business people, and many other professionals to communicate about projects they are working on together. Types of electronic communication include email, video conferencing, blogs, and social media platforms. People with similar interests can meet through social media or email and share information. When using social media or email with strangers, do not share personal information such as phone number or address. Pictures should not be shared with unknown parties using digital communication such as social media or email.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Understand that information can be communicated electronically. • Describe different types of electronic communication.	Students should *investigate* these concepts: • What are different ways that people communicate electronically? • Why do people want to communicate in different ways?	Students should be *introduced* to these concepts: • Blog • Email • Social media • Video conference

Grade 2

Term	Definition
Appropriate	Suitable use
Attribute	Physical description of an object (e.g., color, shape, size)
Author	The creator of a book, image, song, or object
Block-based programming language	Environment to create a program by fitting together command blocks in a sequence
Blog	An informal website that is regularly updated by an individual or group
Computing device	An electronic device that can store and receive information
Cyberbullying	The use of electronic communication to bully a person
Data	Individual facts and information
Debug	Find and fix problems in a program
Digital artifact	An object that is made or stored on a computer
Email	Program used to communicate online
Event	Something that causes a portion of a program to run (e.g., a mouse click)
Graphic organizer	A visual display of terms, facts, and ideas
Hardware	Physical components of a computing system
Illustrator	Creator of a visual artifact (e.g., image or painting)

Term	Definition
Inference	A conclusion reached on the basis of evidence and reasoning
Input	Data that is taken in by a computer for processing
Internet	A global computer network that allows people to communicate, create, and share content
Loop	A set of actions repeated until a condition is met
Model	Creating a representation of an idea, object, or a process
Output	Data that is produced by a computer as a result of a program
Password	A secret word or phrase that must be used to gain admission to something
Pattern matching	Finding similarities between things
Prediction	Making a guess of what will happen based on current facts
Program	An algorithm that has been coded into something that can be run by a machine
Reboot	Turn off a computer and then turn it on again
Repeat	To perform an action or set of actions multiple times in a row
Sequence	An ordered set of instructions
Social media	Applications that allow people to communicate and share content with each other
Software	The programs used by a computing system
Storyboard	A sequence of drawings that represent the order of a program happening
Troubleshoot	Identify and correct faults in a computing system

Term	Definition
Video conferencing	Communicating with someone on the Internet with both audio and video
Website	A location on the Internet referenced by a WWW address