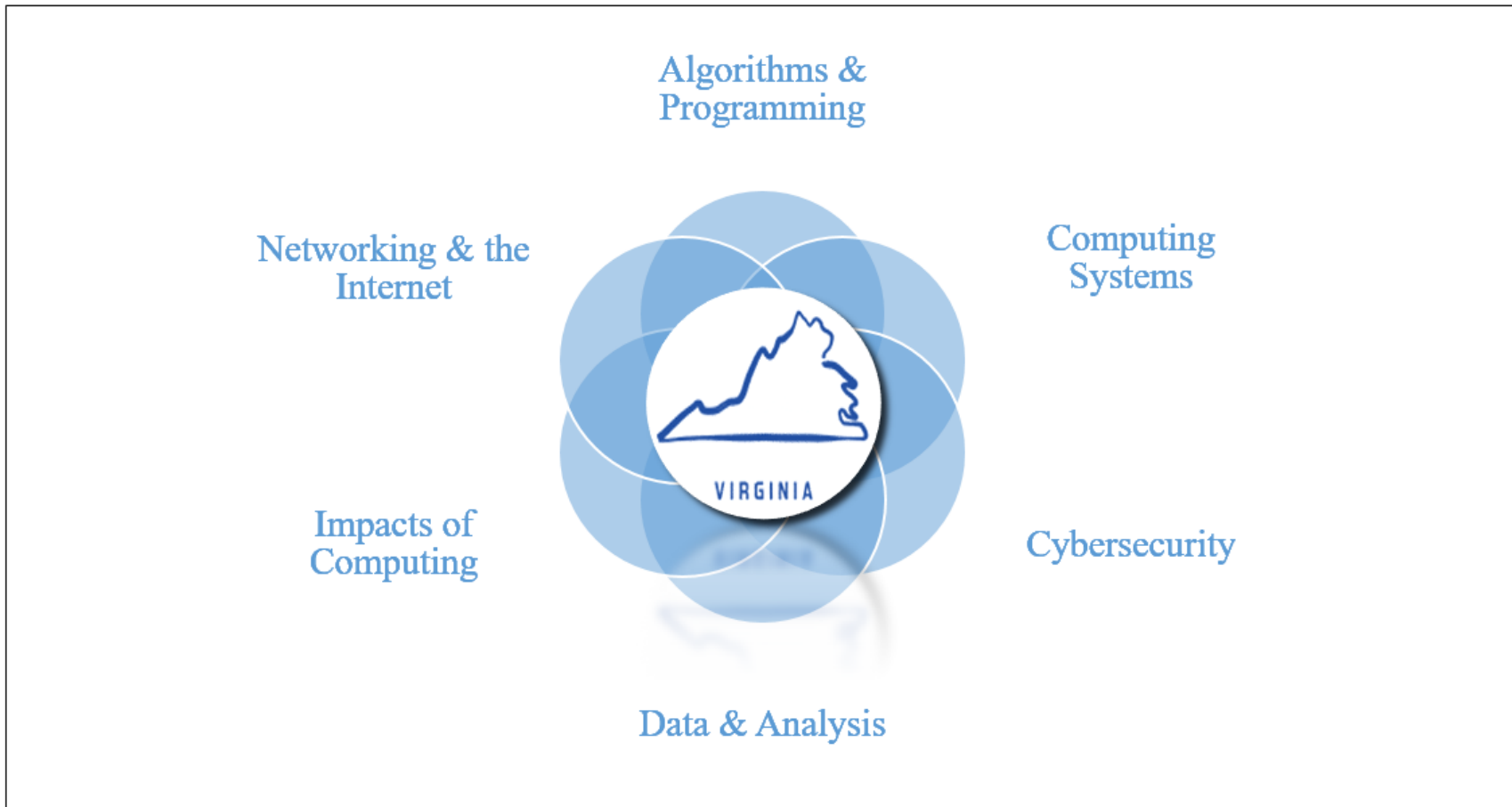


# Computer Science Standards of Learning Curriculum Framework



Board of Education  
Commonwealth of Virginia

Copyright © 2019  
by the  
Virginia Department of Education  
P.O. Box 2120  
Richmond, Virginia 23218-2120  
<http://www.doe.virginia.gov>

All rights reserved. Reproduction of these materials for instructional purposes in public school classrooms in Virginia is permitted.

**Superintendent of Public Instruction**

James F. Lane, Ed.D.

**Assistant Superintendent of Learning**

Gena Keller

**Office of Science, Technology, Engineering, and Mathematics**

Tina Manglicmot, Ed.D., Director

Anne Petersen, Ph.D., Science Coordinator

Timothy Ellis, Computer Science Specialist

Joshua Bearman, Science Specialist

**NOTICE**

The Virginia Department of Education does not discriminate on the basis of race, sex, color, national origin, religion, age, political affiliation, veteran status, or against otherwise qualified persons with disabilities in its programs and activities.

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).

## Kindergarten

The kindergarten standards place emphasis on developing awareness of computing and computing devices by gathering and organizing data and sequencing actions. Students will use accurate terminology to identify components of a computer and describe their purposes. Students will also be introduced to communication, security, and responsible computing behaviors. The use of technology will be an integral part of successful acquisition of skills in all content areas.

### Algorithms and Programming

K.1 The student will construct sets of step-by-step instructions (algorithms) either independently or collaboratively including sequencing, emphasizing the beginning, middle, and end.

#### 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.

As students learn to construct simple algorithms that reflect a daily activity, they realize that the sequences have a beginning, middle, and end. Just as people use algorithms to complete daily routines, they can program computers to use algorithms to complete different tasks. Algorithms are commonly implemented using a precise language that computers can interpret.

Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• Identify daily activities that are completed using a sequence of steps.</li> <li>• As a class, construct a sequence of steps to accomplish an activity.</li> <li>• Identify the beginning, middle and end of a sequence of steps.</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• What are examples of activities that are part of a daily routine?</li> <li>• What are the steps of an activity that you perform frequently?</li> <li>• How does having a defined sequence of steps make an activity easier?</li> </ul>	<p>Students should be <i>introduced</i> to these concepts:</p> <ul style="list-style-type: none"> <li>• Sequence</li> </ul>

K.2 The student will construct programs to accomplish tasks as a means of creative expression using a block-based programming language or unplugged activities, either independently or collaboratively, including sequencing, emphasizing the beginning, middle, and end.

<b>Context of the Standard</b>
<p>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 an algorithm is called programming and is used to create a wide variety of products such as video games, interactive art projects, and digital stories.</p> <p>The sequencing of tasks and the testing of programs can be done with or without the use of a computer. When it is done without a computer it is considered an unplugged activity. Unplugged activities allow students to understand the sequencing and testing process in a concrete way. Unplugged activities can be found at sites such as <a href="#">CS Unplugged</a>.</p> <p>Programs can also be developed and tested using computer applications; these are referred to as plugged activities. Students may use block-based programs to sequence steps as they develop simple computer programs.</p>

Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• As a class, construct a sequence of steps to accomplish an activity (unplugged).</li> <li>• Recognize that a sequence of steps when using a computer is called a program.</li> <li>• As a class or individually, use a block-based programming language (e.g., Scratch Jr.) or unplugged activity to complete a simple task as a form of creative expression.</li> <li>• Model the steps of a program using coding cards or similar instructional strategy.</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• How would you describe a series of steps that you do every day to complete an activity (brushing your teeth, putting on a shirt, etc)?</li> <li>• Why is it important that some tasks have a beginning, middle, and end?</li> <li>• What would happen if a set of instructions began in the middle, rather than at the beginning?</li> </ul>	<p>Students should be <i>introduced</i> to these concepts:</p> <ul style="list-style-type: none"> <li>• Algorithm</li> <li>• Program</li> <li>• Sequence</li> </ul>

K.3 The student will create a design document to illustrate thoughts, ideas, and stories in a sequential (step-by-step) manner (e.g., story map, storyboard, and sequential graphic organizer).

<b>Context of the Standard</b>
<p>As students listen to stories, they realize that these stories have a beginning, middle, and end. Authors use multiple ways of creating a story; stories can be told using story maps, storyboards, or graphic organizers. Just as authors sequence events in a story, people may use computers as they work together to plan, create, and test programs. Programming is used as a tool to create products that reflect a wide range of interests, such as video games, interactive art projects, and digital stories.</p>

Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• Design a sequence using a visual tool such as storyboard.</li> <li>• Use illustrations to tell a story that has a beginning, middle, and end.</li> <li>• Using a graphical representation (graphic organizer, storyboard, or story map), retell a story by arranging the events in the correct sequence.</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• What tools can an author/comic book artist/movie director use to write a story?</li> <li>• Why would authors want different ways to organize a story?</li> </ul>	<p>Students should be <i>introduced</i> to these concepts:</p> <ul style="list-style-type: none"> <li>• Design document</li> <li>• Storyboard</li> <li>• Graphic organizer</li> </ul>

K.4 The student will categorize a group of items based on one attribute or the action of each item, with or without a computing device.

<b>Context of the Standard</b>
<p>Objects and actions have attributes; these attributes allow people to group items. Attributes may be physical properties such as color, shape or form, texture, and size. Actions may be categorized as movement such as those seen in step-by-step sequences (algorithms). Actions may include back and forth movement, turning, and stopping. Categorizing relies on careful observation of patterns and similarities and differences. These similarities and differences can be used to categorize using both unplugged activities and computer devices.</p>



Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• Identify the attributes of an object (e.g., color, size, shape, thickness, actions).</li> <li>• Sort and classify objects into appropriate groups (categories) based on one attribute.</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• How do people describe different cars/animals/movements/etc.?</li> <li>• How do people organize different objects into categories?</li> <li>• How would you compare and contrast two basic actions (taking a step vs. turning your head, for example)?</li> </ul>	<p>Students should be <i>introduced</i> to these concepts:</p> <ul style="list-style-type: none"> <li>• Pattern Matching</li> <li>• Program</li> </ul>

### Computing Systems

K.5 The student will identify components of computing systems (e.g., keyboard, mouse, desktop computer, laptop computer, tablet, and printer).

Context of the Standard
<p>Computing systems are composed of different components. These components enable the user to complete different tasks using a computing system.</p> <p>Common components among desktop and laptop computers, tablets, and mobile phones include a keyboard (either physical or screen based) for inputting information, audio for hearing information, and a screen for viewing information.</p>

Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• Identify a keyboard, mouse/trackpad, and printer.</li> <li>• Describe the purpose of the keyboard, mouse/trackpad, and printer.</li> <li>• Demonstrate proper use of a mouse/trackpad and keyboard.</li> <li>• Identify different computing systems such as a desktop computer, laptop computer, tablet, and mobile device.</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• How does using a mouse or keyboard make computing easier?</li> <li>• What are different computing devices used at home or in school?</li> </ul>	<p>Students should be <i>introduced to</i> these components:</p> <ul style="list-style-type: none"> <li>• Keyboard</li> <li>• Mouse</li> <li>• Trackpad</li> <li>• Desktop computer</li> <li>• Laptop computer</li> <li>• Mobile Device</li> <li>• Tablet</li> <li>• Printer</li> </ul>

K.6 The student will identify, using accurate terminology, simple hardware and software problems that may occur during use (e.g., app or program is not working as expected, no sound is coming from a device, device will not turn on).

<b>Context of the Standard</b>
<p>Computing systems might not work as expected because of hardware or software problems. Clearly describing a problem is the first step toward finding a solution. In kindergarten, students are expected to clearly describe a problem in the computing system using developmentally appropriate language. Examples include, “The computer won’t turn on,” “The pointer on the screen won’t move,” or “I lost the web page.”</p> <p><i>Students are not expected to diagnose or troubleshoot a problem with a computing system in Kindergarten.</i></p>

Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• Identify when a device or program is not working properly. <i>Students are not expected to differentiate between software and hardware.</i></li> <li>• Communicate that a device or program is not working.</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• How can you tell if your device is not working properly?</li> <li>• What are ways you can describe the problem to your teacher?</li> </ul>	<p>Students should be <i>introduced</i> to these concepts:</p> <ul style="list-style-type: none"> <li>• Computing device</li> <li>• Keyboard</li> <li>• Mouse</li> <li>• Printer</li> </ul>

### Cybersecurity

K.7 The student will identify what is allowed and what is not allowed at school when using technology.

<b>Context of the Standard</b>
<p>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.</p>

Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• Classify computer actions as allowed or not allowed based on school rules.</li> <li>• Communicate process for reporting inappropriate use of technology.</li> <li>• Demonstrate proper care for electronic devices (e.g., handling, logging off or shutting down correctly, and keeping devices away from water/food).</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• What are your school’s rules about computer use?</li> <li>• Why does the school have rules that students and teachers need to follow?</li> <li>• Why are the rules at school different (maybe) than those that you have at your house?</li> <li>• How could improper use of a computer be harmful to someone else?</li> <li>• How could improper use of a computer be harmful to you?</li> </ul>	<p>Students should be <i>introduced</i> to these concepts:</p> <ul style="list-style-type: none"> <li>• Digital Citizenship</li> <li>• Computing Device</li> <li>• Digital Safety</li> </ul>

K.8 The student will identify personal information (e.g., address, telephone number, and name) and the importance of protecting personal information online.

Context of the Standard
<p>Connecting devices to a network or the Internet provides many benefits, but care must be taken to ensure that personal information is not shared with others. Personal information includes a student’s name, address, and phone number. When using a computing system, personal information such as computer passwords are not to be shared with others in the classroom. Students and teachers should never share personal information with anyone on the Internet. Privacy should be considered when posting information online; such information can persist for a long time and be accessed by others, even unintended viewers.</p>

Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• Explain why they should not share personal information.</li> <li>• Explain the importance of passwords.</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• What are some examples of information that should not be shared with strangers?</li> <li>• What are some ways people can protect information on their computer?</li> </ul>	<p>Students should be <i>introduced</i> to these concepts:</p> <ul style="list-style-type: none"> <li>• Digital Citizenship</li> <li>• Digital Safety</li> <li>• Personal information</li> </ul>

### Data and Analysis

K.9 The student will gather and display data and organize it in a chart or graph in order to answer questions about the data, with or without a computing device.

<b>Context of the Standard</b>
<p>Students use their senses to make observations and to collect data about the world around them. Data are pieces of information collected about people or things. These data can be recorded in tables and can be used to construct object graphs or picture graphs. Everyday digital devices can also be used to collect and display data over time. Cell phones, digital toys, and cars can contain tools (such as sensors) and computers to collect and display data from their surroundings.</p>

Essential Skills	Essential Questions	Essential Vocabulary
<p>Students should <i>demonstrate</i> these skills:</p> <ul style="list-style-type: none"> <li>• Collect data on categories identified by the teacher and/or student.</li> <li>• Represent gathered data in tables (vertically or horizontally).</li> <li>• Represent data by arranging concrete objects into organized groups to form a simple object graph.</li> <li>• Use data to answer questions.</li> <li>• Represent gathered data, using pictures to form a simple picture graph.</li> </ul>	<p>Students should <i>investigate</i> these concepts:</p> <ul style="list-style-type: none"> <li>• Why do we collect data?</li> <li>• What are examples of data?</li> <li>• What are ways that we can arrange data?</li> <li>• What questions can be answered with a set of collected data?</li> </ul>	<p>Students should be <i>introduced</i> to these concepts:</p> <ul style="list-style-type: none"> <li>• Data</li> <li>• Table</li> <li>• Object graph</li> <li>• Picture graph</li> </ul>

### Impacts of Computing

K.10 The student will identify responsible behaviors associated with using information and technology.

#### Context of the Standard

Using computers comes with a level of responsibility, 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 intimidating and inappropriate behavior in the form of cyberbullying.

*Students are not responsible for the term or description of cyberbullying in Kindergarten.*

<b>Essential Skills</b>	<b>Essential Questions</b>	<b>Essential Vocabulary</b>
Students should <i>demonstrate</i> these skills: <ul style="list-style-type: none"> <li>• Interact responsibly with peers when using technology.</li> <li>• Describe what information should be shared and not shared.</li> <li>• Describe online behaviors that may be harmful to others.</li> </ul>	Students should <i>investigate</i> these concepts: <ul style="list-style-type: none"> <li>• What are behaviors used in school to keep people safe online?</li> <li>• How are responsible computer behaviors important to good citizenship?</li> </ul>	Students should be <i>introduced</i> to these concepts: <ul style="list-style-type: none"> <li>• Digital Citizenship</li> <li>• Computing Device</li> <li>• Digital Safety</li> </ul>

### **Networking and the Internet**

K.11 The student will discuss, in a whole class setting, how information can be communicated electronically (e.g., email, social media).

<b>Context of the Standard</b>
Communication channels have increased with the use of electronic devices. Devices such as cell phones and computers, allow people to communicate through email, texts, video calling, and social media. With many means of sharing information, computer safety policies need to be reviewed and reinforced on a regular basis.

<b>Essential Skills</b>	<b>Essential Questions</b>	<b>Essential Vocabulary</b>
Students should <i>demonstrate</i> these skills:	Students should <i>investigate</i> these concepts:	Students should be <i>introduced</i> to these concepts:

<b>Essential Skills</b>	<b>Essential Questions</b>	<b>Essential Vocabulary</b>
<ul style="list-style-type: none"> <li>• Understand that information can be communicated electronically.</li> <li>• Describe different types of electronic communication.</li> </ul>	<ul style="list-style-type: none"> <li>• What are different ways people communicate with each other?</li> <li>• What are different ways people can communicate with a computer?</li> </ul>	



## Grade K

Term	Definition
Algorithm	A list of steps to finish a task
Appropriate	Suitable use
Computing Device	An electronic device that can store and receive information
Data	Individual facts and information
Design document	Written description of a program or story
Desktop computer	A stationary computing device
Digital Citizenship	Responsible behavior with technology
Digital Safety	Protecting yourself while using devices
Email	Program used to communicate online
Graphic organizer	Visual display of the relationship between terms, objects, or ideas
Hardware	The physical parts of a computer
Internet	A network of interconnected networks
Keyboard	An input device used to enter text on a screen
Laptop computer	A mobile computing device
Mobile Device	A small handheld computing device that primarily uses touch input as a control device
Mouse	An input device used to move items on the screen and navigate

Term	Definition
Object graph	Physically organizing objects according to a category
Pattern Matching	Finding similarities between things
Persistence	Trying again and again, even when something is very hard
Personal information	Specific information about a student
Picture graph	Pictorial display of data with symbols, icons, and pictures to represent different quantities
Printer	An output device that displays the result on paper
Program	An algorithm that has been coded into something that can be run by a machine
Protect	To keep safe
Reboot	To turn off the device and turn it back on
Sequence	An ordered set of instructions
Software	The programs that run on the computer
Storyboard	Visual organization of sequential pictures that outline a program or story
Table	Information (such as numbers and descriptions) arranged in rows and columns
Tablet	A handheld computing device that primarily uses touch input
Trackpad	An input device used to move items on the screen and navigate
Troubleshoot	Actions taken to solve a problem with hardware or software
WiFi	Technology that uses radio waves to provide Internet activity