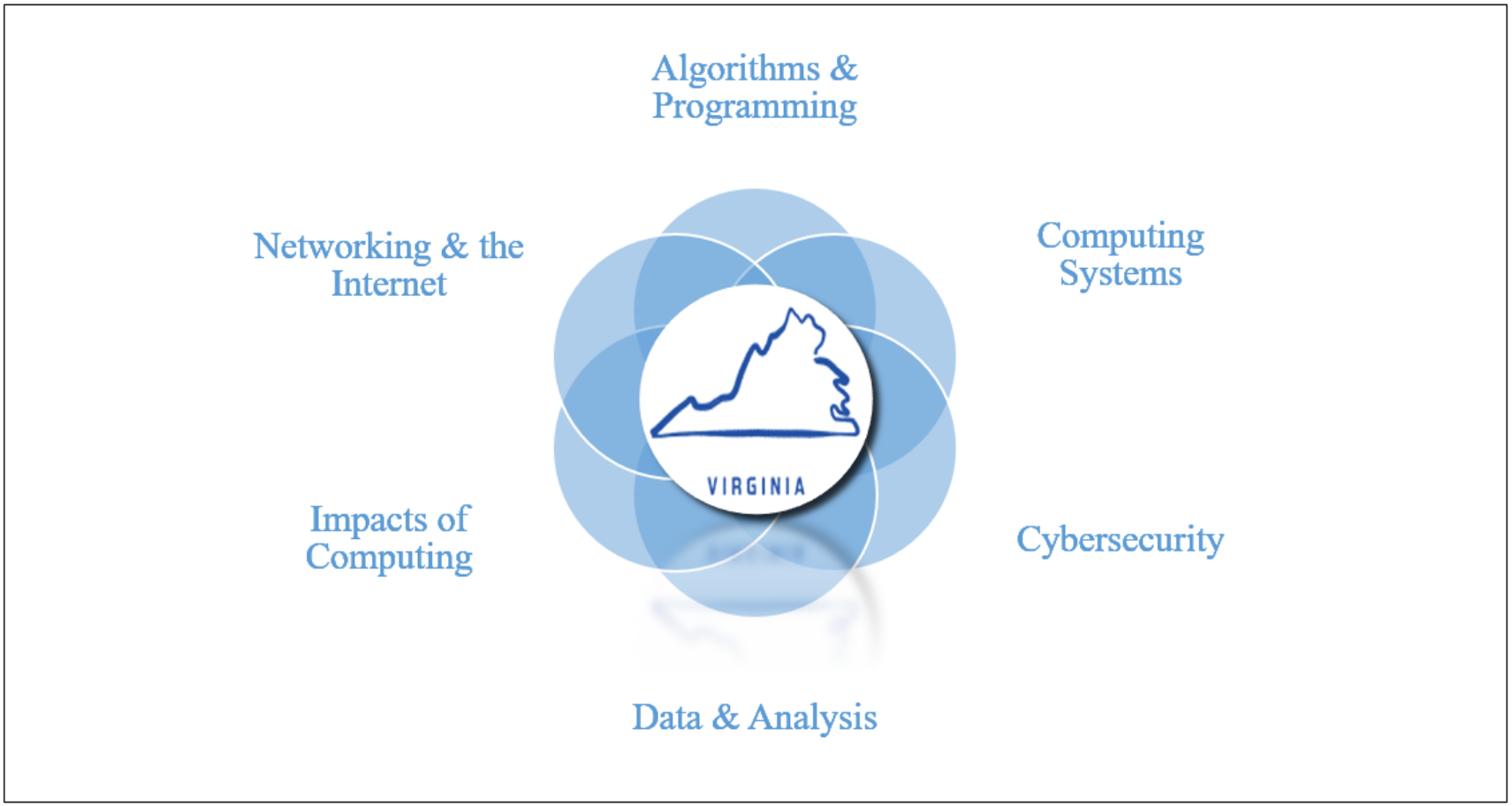
Computer Science Standards of Learning

Curriculum Framework



Board of Education
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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 One

The first grade standards place emphasis on developing organizational skills, such as classifying based on common attributes, completing a pattern, or explaining step-by-step processes. Students will use accurate terminology to identify components and describe their purposes. Students will also be able to describe 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

1.1 The student will construct sets of step-by-step instructions (algorithms) either independently or collaboratively, including

a. sequencing (including ordinal numbers) and;
b. simple loops (patterns and repetition).

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. As an example, walking forward 10 steps and turning could be repeated 4 times to illustrate a square. A loop allows the core of the pattern to be written once instead of 4 times, shortening the overall length of the algorithm. Algorithms can be created with or without computers. Computers follow precise sequences of instructions that automate tasks. A precise sequence of instructions that a computer uses is referred to as a program. Programs are sequential and may contain loops. Unplugged activities can be found at sites such as CS Unplugged.

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills: • Individually and/or as a class, construct a sequence of steps to accomplish an activity. • Identify a section of repeated actions to replace with a loop. • Given a sequence of steps that include a loop, predict the next step in the sequence.	Students should *investigate* these concepts: • When would a loop be used when describing a sequence of steps? • What is an example of a daily task that includes a loop? • Given a pattern of numbers or images, how can you predict what should come next in this series?	Students should be *introduced* to these concepts: • Loop • Pattern matching • Repeat • Sequence

1.2 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

a. sequencing, ordinal numbers; and
b. simple loops (patterns and repetition).

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 program is called programming and is used to create a wide variety of products such as video games, interactive art projects and digital stories. In first grade, students are expected to develop and test simple algorithms that include both sequencing and simple loops to complete a task. Block-based programs (i.e. Scratch Jr., Tynker) allow students to develop simple algorithms using a computer. Students can also create simple unplugged programs that don't require a computer but contain sequencing and loops through the use of coding cards, mazes, and other activities that provide students opportunities to describe tasks as a sequence of events.

Essential Skills	Essential Questions	Essential Vocabulary
Students should *demonstrate* these skills: • As a class, construct a sequence of steps to accomplish an activity (unplugged). • 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. • 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. • Model the steps of a program that contains at least one loop using coding cards or similar instructional strategy.	Students should *investigate* these concepts: • How can you write a series of steps to complete an action? • When is it useful to use a loop?	Students should be *introduced* to these concepts: • Loop • Program • Block-based programming language

1.3 The student will analyze, correct, and improve (debug) an algorithm that includes sequencing.

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

Context of the Standard
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 is works as intended is called debugging.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Understand that algorithms and/or programs may not always work correctly. • Describe how an algorithm does not work (e.g., character is not moving as intended). • As a class, analyze a simple sequence of steps that is flawed and determine possible solutions.	Students should *investigate* these concepts: • If something is not working, how do you figure out what is broken? • What does "bug" mean when we are talking about an algorithm? • How can you tell if a program or sequence has a bug? • What are the steps to take when you are trying to locate a bug in a program or sequence?	Students should be *introduced* to these concepts: • Debug • Program

1.4 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 listen to stories, they realize that these stories have a beginning, middle, and end. 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. Authors use multiple ways of planning and telling a story; stories can be told using story maps, storyboards, or graphic organizers.

Context of the Standard
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: • Design a sequence using a visual tool such as storyboard. • Use illustrations to tell a story that has a beginning, middle, and end. • Using a graphical representation (graphic organizer, storyboard, or story map) to retell a story by arranging the events in the correct sequence.	Students should *investigate* these concepts: • Why should you plan a story before beginning to write? • What tools can a programmer use to plan?	Students should be *introduced* to these concepts:

1.5 The student will categorize a group of items based on one or two attributes or the 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 such as color, shape, 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. In this standard, students are expected to group items based on one or two attributes or actions.

Context of the Standard
In the science and mathematics standards the term classify is used when grouping objects or organisms based on one or more attributes. In block-based programming environments, commands are grouped into categories based on function. In higher level programming languages, the kind or type of data determines the classification.

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Sort and group (classify) objects into appropriate groups (categories) based on one or two 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: • Why is it useful to organize objects into categories? • Given a set of objects/drawings, what are ways to group these objects or actions? What attributes did you use to group these objects or actions? • Given a set of objects/drawings, what attributes do you think a person used to group these objects? What is another way you can group these objects? • Given assorted objects, how would you group these items using two different attributes?	Students should be *introduced* to these concepts: • Attribute

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

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 we use in our classroom and in our homes. This standard begins an exploration of the concepts of intellectual property laws and plagiarism. *Students are not responsible for these terms in first grade.*

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Explain that artifacts have owners. • State whether an artifact was 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.	Students should *investigate* these concepts: • How can you tell who wrote a book or painted a picture? • What does it mean to give credit? • Why is important to give someone credit for their work? • What is the difference between using someone's idea and copying their idea?	Students should be *introduced* to these concepts: • Author • Artifact • Illustrator

Computing Systems

1.7 The student will identify components of computing systems that are common among different types of computing devices including desktop and laptop computers, tablets, and mobile phones.

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

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Identify different computing systems such as a desktop computer, laptop computer, tablet, and mobile device. • Identify the keyboard, mouse/trackpad, and printer. • Describe the purpose of the keyboard, mouse/trackpad, and printer. • Compare and contrast the components used by different computing systems (desktop, laptop, tablet, mobile device). • Demonstrate proper use of a mouse/trackpad and keyboard.	Students should *investigate* these concepts: • What are the components that are shared between desktops, laptops, and tablets? • What are the components that are different between desktops, laptops, and tablets? • How do the different components (keyboard, mouse, printer, etc.) of a computing system help you accomplish a given task?	Students should be *introduced* to these concepts: • Desktop Computer • Keyboard • Laptop Computer • Mobile Device • Mouse • Printer • Tablet • Touch Screen

1.8 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 the device, the device won't turn on).

Context of the Standard
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. Problems with computing systems have different causes, such as hardware settings, programming errors, or faulty connections to other devices. Developmentally appropriate ways to solve problems include debugging simple programs and seeking help by clearly describing a problem (e.g., "The computer won't turn on," "The pointer on the screen won't move," or "I lost the web page."). *Students are not expected to diagnose or troubleshoot a problem with a computing system in first grade. Students are not expected to differentiate between software and hardware in first grade.*

Essential Skills	**Essential Questions**	**Essential Vocabulary**
Students should *demonstrate* these skills: • Identify when a device or program is not working properly. • Communicate that a device or program is not working.	Students should *investigate* these concepts: • How can you tell if your device is not working properly? • What are ways you can describe the problem to your teacher?	Students should be *introduced* to these concepts: • Keyboard • Mouse • Desktop computer • Laptop computer • Tablet • Printer

Cybersecurity

1.9 The student will describe what is allowed and what is not allowed at school associated with the use of technology.

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.

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 are the school rules for technology use? • Why do you think the school has rules for technology? • If you were in charge, what rules would you make for technology use and why?	Students should be *introduced* to these concepts: • Digital Safety

1.10 The student will identify and use 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. 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.

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' passwords. • Explain how logging off devices can protect personal information.	Students should *investigate* these concepts: • Why do we use passwords? • What makes a password strong? • What kind of information would you want to protect with a password? • Why is it important not to share passwords?	Students should be *introduced* to these concepts: • Digital Safety • Personal information

Data and Analysis

1.11 The student will identify and interpret 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 object graphs or picture graphs. Everyday digital devices can 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. 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: • Identify different types of data that can be collected. • Collect data on categories identified by the teacher and/or student. • Represent gathered data in tables (vertically or horizontally). • Represent data by arranging concrete objects into organized groups to form a simple object graph. • Represent gathered data, using pictures to form a simple picture graph.	Students should *investigate* these concepts: • What are examples of different data we can collect? • What are ways that we can arrange data? • What are the different types of graphs we can use to represent data? • Given a set of data, what predictions can you make based on the data you have?	Students should be *introduced* to these concepts: • Data • Prediction

Essential Skills	Essential Questions	Essential Vocabulary
• Analyze data and identify patterns that can be used to make predictions.		

Impacts of Computing

1.12 The student will identify and explain 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 a computer device when finished with a task. 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. *Students are not responsible for the term cyberbullying in first grade.*

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 with strangers. • Describe online behaviors that may be harmful to others.	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?	Students should be *introduced* to these concepts: • Digital Citizenship • Digital Safety • Personal information

Networking and the Internet

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

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. People with similar interests can meet through social media or email and share information; however, the public and anonymous nature of online communication also allows intimidating and inappropriate behavior in the form of cyberbullying. 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 people communicate with each other? • What are different ways people can communicate with a computer?	Students should be *introduced* to these concepts: • Email • Social media

Grade 1

Term	Definition
Appropriate	Suitable use
Artifact	An object made by a person
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
Computing device	An electronic device that can store and receive information
Data	Individual facts and information
Debug	Find and fix problems in a program
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
Illustrator	The creator of an image or other visual piece
Keyboard	An input device used to enter text on a screen
Laptop computer	A mobile computing device

Term	Definition
Loop	A set of actions repeated until a condition is met
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
Pattern matching	Finding similarities between things
Personal information	Specific information about a student
Prediction	Making a guess of what will happen based on current facts
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
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
Tablet	A handheld computing device that primarily uses touch input
Touch screen	An input device used to move items on the screen and navigate