Ohio’s Model Curriculum for Computer Science

Grade 3

ADOPTED SEPT. 2022

Ohio | Department of Education

Strand	Computing Systems
Topic	**Devices**

CS.D.3.a Explore common components (i.e., parts) of a computing system and their function to understand and describe the role they play in a computer system.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students began selecting devices with a purpose in mind. In grade 3, students develop an understanding that the device they selected for a specific task has components (i.e., parts) that play a role in the computer system. In grade 4, students will develop their understanding of what external components are used to share information locally and globally.

IMPORTANT CONCEPTS

- External devices are used to input data into the computer.
- Different devices have different purposes.
- Each external component (i.e., part) has a different function in a computer system.

KEY SKILL/PROCEDURES

- Identify key components (i.e., parts) such as keyboard, trackpad/mouse, monitor, printer, tablet, etc.
- Select an appropriate device to accomplish a task.
- Describe the components of the selected device.

Content Elaborations

CLARIFICATIONS

Different devices may include a personal computer, tablet, laptop, or smartphone. External components (i.e., parts) include a keyboard, mouse/trackpad, monitor/screen, USB port and drive. Sometimes, a component (part) on a device can have multiple functions. For example, a screen can have multiple functions when the screen also serves as the trackpad or keyboard.

CONTENT FOCUS

The focus should be on students understanding the components (i.e., parts) of the device that they select for their task. If they selected a tablet, students should understand that various parts may perform multiple tasks. For example, the screen serves as a monitor and input device with a keyboard.

COMPUTER SCIENCE PRACTICES

Practice 2. Collaborating Around Computing

4. Evaluate and select technological tools that can be used to collaborate on a project.

Strand	Computing Systems
Topic	**Hardware and Software**

CS.HS.3.a Identify and use digital learning tools/devices to support planning, implementing and reflecting upon a defined task.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students began selecting devices with a purpose in mind. In grade 3, students select learning tools or devices to plan, implement and reflect upon tasks. In grade 4, students will continue to select learning tools and devices and will use them to aid in planning, implementing and reflecting upon given tasks.

IMPORTANT CONCEPTS

- Different types of software and hardware can be used to accomplish a task.
- Learning tools should support the planning, implementation and reflection of a task.

KEY SKILL/PROCEDURES

- Select and use a tool, such as a presentation software program, document, graphic design program or video editing software, to accomplish a given task.
- Select and use an appropriate device, such as a tablet, laptop or desktop to accomplish a given task.

Content Elaborations

CLARIFICATIONS

Tools can range from basic programs, such as word processing and presentation software to other online tools.

CONTENT FOCUS

The focus is on students selecting and using a tool or device to accomplish a task. Students should be given opportunities to self-select a tool to accomplish a task.

COMPUTER SCIENCE PRACTICES

Practice 2. Collaborating Around Computing

4. Evaluate and select technological tools that can be used to collaborate on a project.

Strand	Computing Systems
Topic	**Troubleshooting**
CS.T.3.a Apply troubleshooting strategies given problems and solutions to resolve hardware and software problems.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 2, students continued to work on their use of problem-solving. In grade 3, students begin to move beyond trial and error to apply more strategic troubleshooting techniques to fix their problems. In grade 4, students will focus on diagnosing and describing potential hardware and software problems. **IMPORTANT CONCEPTS** • Troubleshooting strategies can be used to solve hardware and software issues. **KEY SKILL/PROCEDURES** • Use a troubleshooting technique to solve a given problem. **Content Elaborations** **CLARIFICATIONS** Examples of problems to troubleshoot at this level may be a computer not connecting to the network or not turning on. Students should state what the problem is instead of just referring to the problem as "the computer is broken." **CONTENT FOCUS** The focus is on students using targeted troubleshooting techniques to solve given problems. **COMPUTER SCIENCE PRACTICES** *Practice 6*. Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process.

Strand	Networks and the Internet
Topic	**Networking**

NI.N.3.a Describe how communication occurs when information is sent and received over physical or wireless paths to explain communication systems (e.g., sending an email or visiting a website).

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students described what a network was, the devices we use to network, how devices can be identified, and how they can be connected. Additionally, students networked using devices to access and retrieve information within a global community. In grade 3, students explore how information is sent and received over the internet. In grade 4, students will elaborate on how information is broken down and transmitted before it is received.

IMPORTANT CONCEPTS

- A web address or URL has a different function than searching for content.
- Information is communicated through a wired or wireless connection.

KEY SKILL/PROCEDURES

- Enter a precise address to reach a site.
- Recognize whether a network (i.e., internet) connection is present.
- Conduct basic troubleshooting techniques based on network connectivity.

Content Elaborations

CLARIFICATIONS

Students often confuse the address bar for the search bar when attempting to access a website. Students should understand that these have two different functions, and a web address should be accessed through an address bar. The web address should be typed in exactly to access the site they are attempting to reach.

Students should understand that online information cannot be accessed without a network connection. They should be able to recognize whether a network connection is present.

Basic troubleshooting techniques for network connectivity could include restarting a device, refreshing a webpage or attempting to reconnect to the network.

CONTENT FOCUS

The focus is on students entering a precise URL (web address) into the address bar to reach a site and recognizing that reaching this site cannot be done without a network connection.

Strand	Networks and the Internet
Topic	**Networking**
	COMPUTER SCIENCE PRACTICES *Practice 4*. Developing and Using Abstractions 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Strand	Networks and the Internet
Topic	**Networking**

NI.N.3.b Recognize that every device on a network has a unique identifier to share or receive information from the global community.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students described what a network is, the devices we use to network, how devices can be identified and how they can be connected. Additionally, students networked using devices to access and retrieve information within a global community. In grade 3, students continue to build an understanding of how information is shared, received and stored. In grade 4, students will build their vocabulary around these concepts.

IMPORTANT CONCEPTS

- Similar to a personal mailing address, every device has a unique address for sending or receiving information.

KEY SKILL/PROCEDURES

- Recognize that every device has a unique network address.

Content Elaborations

CLARIFICATIONS

Students should understand that their device has a unique address. This is like their mailing address in the sense that the information knows where to travel based on the address.

CONTENT FOCUS

The focus is on students recognizing that devices have unique web addresses.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Strand	Networks and the Internet
Topic	**Cybersecurity**

NI.C.3.a Explore digital safety concepts in order to explain that information can be both public and private, to determine what information can safely be shared and to know how to use passwords to protect information.

Expectations for Learning

LEARNING PROGRESSION

In K-2, students have had experience identifying private and public information. In grade 3, students explore and understand personal information and how passwords are used to protect that information. In grade 4, students will describe the importance of using a secure password to protect personal information.

IMPORTANT CONCEPTS

- Personal information is valuable and both private and sharable.
- Personal (private) information should be protected by passwords.

KEY SKILL/PROCEDURES

- Explain private vs. public information and that this is called personal information.
- Explain why passwords are used.

Content Elaborations

CLARIFICATIONS

Students struggle with what to share or not to share, which is private or public information. They should make the connection between that and personal information.

Students often think it is okay to share their passwords with their peers. They need to connect passwords with something that needs to be private.

CONTENT FOCUS

The focus is on students exploring and understanding different types of personal and public information and why passwords are important.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.

Strand	Networks and the Internet
Topic	**Cybersecurity**

NI.C.3.b Explore and explain grade-appropriate examples of unsafe content, such as pop-ups and malicious links.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students will explore and explain grade-appropriate examples of unsafe content.
In grade 4, students describe the effects of malicious content. In grade 5, students will analyze the inappropriate use of online services.

IMPORTANT CONCEPTS

- Personal information is valuable and both private and sharable.
- Personal (private) information should be protected.
- Threats including malware, ransomware and others are connected to the online environment.

KEY SKILLS/PROCEDURES

- Describe malware and pop-ups.
- Describe and identify online threats.
- Describe and identify social engineering concepts.
- Understand and practice cyber hygiene.

Content Elaborations

CLARIFICATIONS

Students often do not know what happens when you click a link on a web page and should be taught that links could lead to inappropriate websites. Students should know the different types of pop-up messages and their meaning. Students need to know that some pop-up messages are not safe and could lead to improper websites or downloading malicious content. Students should know that there are many appropriate uses for pop-up messages and windows.

CONTENT FOCUS

The focus is on students understanding different types of digital threats to personal and public information and why understanding basic cyber hygiene and awareness is important for all students. Students should be able to discuss examples of mitigation of digital threats including malware and pop-ups.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.

Strand	Networks and the Internet
Topic	**Internet of Things**

NI.IOT.3.a Describe how devices send and receive information over physical or wireless paths to identify how information is transmitted.

NI.IOT.3.b Define intelligent devices and describe the difference between smart devices and intelligent devices to identify the difference in their capabilities.

Expectations for Learning

LEARNING PROGRESSION

In grade 2 students explained how devices connect and exchange data. Additionally, they explored different network connectivity. In grade 3, students describe information transmission, explore, and explain the difference between smart and intelligent devices. In grade 4, students will recognize how smart devices communicate over the internet and see how network communication can be traced.

IMPORTANT CONCEPTS

- Devices send and receive information both wirelessly (Wi-Fi, Bluetooth, etc.) and through wired connections.
- A smart device (such as a Virtual Assistant) is a device that has connectivity, captures useful data and presents it.
- An intelligent device is a smart device that adapts or learns.

KEY SKILLS/PROCEDURES

- Describe the basic difference between wireless and wired connections.
- Define and recognize the difference between smart and intelligent devices, as well as how humans interact with them differently.

Content Elaborations

CLARIFICATIONS

Explain and distinguish between smart devices such as Bluetooth, Wi-Fi and Virtual Assistants. Provide examples of Smart vs. Intelligent devices.

CONTENT FOCUS

Explore the difference between smart and intelligent devices and understand how they communicate using networks.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating About Computing

2. Describe, justify and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Strand	Data and Analysis
Topic	**Data Collection and Storage**

DA.DCS.3.a Collect quantitative data over time from multiple sources to perform various tasks.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students had experience collecting, sorting and organizing data. In grade 3, students collect, record and maintain data over time using various tools, such as a thermometer, ruler, scale and survey. In grade 4, students will begin to explore various computational tools for collecting data from multiple sources over time.

IMPORTANT CONCEPTS

- Keeping an organized record of data over time is critical to analyzing data.
- Various tools can be used to collect data.
- Different tools are used to collect different types of data.

KEY SKILL/PROCEDURES

- Use appropriate tools to collect data.
- Use appropriate tools to organize data.
- Maintain accurate data over some time.
- Collect data by making repeated observations over time.

Content Elaborations

CLARIFICATIONS

Tools that may be explored are digital thermometers, GPS sensors, calculators, scales, digital forms (survey tools), length measurement tools, a stopwatch, etc.

Data can be organized by using various digital and non-digital tables. Digital organizational resources could include spreadsheets and online graphing programs.

CONTENT FOCUS

The focus is on students collecting, recording, maintaining and organizing data over time, rather than communicating data through graphs and charts.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating About Computing

1. Select, organize and interpret large data sets from multiple sources to support a claim.

Strand	Data and Analysis
Topic	**Data Collection and Storage**

DA.DCS.3.b Identify different types of information to store in different formats.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students had experience collecting, sorting, and organizing data. In grade 3, students can use different software tools to access data and store it in different locations. In grade 4, students will begin to gain an understanding that different file types may require different storage.

IMPORTANT CONCEPTS

- Data is stored in different locations on a computing device.
- Data can be stored locally, on a computing device or online.
- Where data is stored impacts accessibility.

KEY SKILL/PROCEDURES

- Store, locate and retrieve data on a computing device.

Content Elaborations

CLARIFICATIONS

Examples of data storage could include saving to a device, local network or the cloud.

Accessibility refers to the ability to retrieve data. Students should understand that data saved to a device will not be accessible without that same device. Accessibility also refers to the ability to open file formats on different devices.

Information refers to data, which could include pictures, audio, video and documents.

CONTENT FOCUS

The focus is that data storage impacts the accessibility of information.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating About Computing

1. Select, organize and interpret large data sets from multiple sources to support a claim.

Strand	Data and Analysis
Topic	**Visualization and Communications**

DA.VC.3.a Create a chart or graph to inform a target audience about observations and data collected.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students continued to analyze data in various visual formats. In grade 3, students extend their knowledge by creating scaled pictures and bar graphs. They will also create line plots using scales that include whole numbers and fractions (e.g., halves and fourths). In grade 4, students will interpret data in self-created graphs to present insights.

IMPORTANT CONCEPTS

- A symbol on a graph (e.g., picture, bar) can represent more than one item.
- A key on a graph indicates how many items a symbol represents.
- A scale on a bar graph varies depending on the data available.
- Symbols used in picture graphs should be evenly spaced to present visually accurate data.

KEY SKILL/PROCEDURES

- Record data with several categories on a scaled bar graph or picture graph.
- Determine the appropriate scale for the data given.

Content Elaborations

CLARIFICATIONS

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 size and symbols on a picture graph should be evenly spaced.

CONTENT FOCUS

The focus is on students taking data they have collected and using a visual representation to communicate the data.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating About Computing

1. Select, organize and interpret large data sets from multiple sources to support a claim.

Strand	Data and Analysis
Topic	**Inference and Modeling**

DA.IM.3.a Utilize data to make predictions and discuss whether there is adequate data to make reliable predictions.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students interpreted and analyzed graphs. In grade 3, students analyze and explain relationships or patterns and predict an unknown. In grade 4, students will determine if adequate data has been collected and run simulations to explore outcomes.

IMPORTANT CONCEPTS

- Data from a graph can be used to determine patterns.
- Data can be used to make predictions about outcomes or to find a missing value.

KEY SKILL/PROCEDURES

- Explain patterns in a data set and determine missing values.
- Analyze patterns and make predictions about outcomes.
- Create a model to identify patterns and essential elements.

Content Elaborations

CLARIFICATIONS

Students explore data and look for patterns. A mathematical connection would be to use in/out (function) machines to find missing values. They solve and make predictions. They begin to discover a pattern cannot continue without a significant number of occurrences.

CONTENT FOCUS

The focus is on students manipulating data to explore patterns and make predictions.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

1. Extract common features from a set of interrelated processes or complex phenomena.

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**

ATP.A.3.a Construct and reflect on errors in an algorithm to accomplish a given task.

Expectations for Learning

LEARNING PROGRESSION

In Grade 2, students constructed and followed directions in a real-world context through written words, statements, and visual symbols. In grade 3, students create algorithms and find errors within an algorithm (i.e., step-by-step task). In grade 4, students will begin refining their created algorithms to accomplish a task.

IMPORTANT CONCEPTS

- An algorithm is a series of steps that will complete a process.
- Logical patterns of progression exist within an algorithm.

KEY SKILL/PROCEDURES

- Utilize logical patterns of progression within an algorithm.
- Recognize and identify errors within an algorithm.
- Recognize pseudocode and flow charts.

Content Elaborations

CLARIFICATIONS

Processes of computational thinking (i.e., logical thought) or beginning, middle and end to create organized steps should be emphasized to decompose an algorithm. Computational thinking also needs to be emphasized to identify where an error has occurred. This can be written in code, pseudocode, real language or flowcharts.

CONTENT FOCUS

The focus is on students using computation thinking (i.e., logical thought) as they work through an algorithm, breaking it into smaller components and determining if an error has occurred somewhere within an algorithm.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems

2. Decompose real-world problems.

Strand	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**

ATP.VDR.3.a Define and identify a variable, a placeholder for storing a value, to understand how it is used in a multi-step process (i.e., algorithm).

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students modeled the use of numbers, symbols and pictures to manipulate and store information. In grade 3, students define and identify variables to understand how they are used in algorithms. In grade 4, students will elaborate on defining and identifying variables.

IMPORTANT CONCEPTS

- Symbols can represent a variable within an algorithm.
- Data can be stored in the variable.

KEY SKILL/PROCEDURES

- Use logical variable representations (symbols).
- Identify where an algorithm might include a variable instead of a value.

Content Elaborations

CLARIFICATIONS

Symbols (e.g., ?, □) are used in programming to hold values. For example, a cloze activity allows students to choose varying words for a single blank within a passage. This is a variable (i.e., a placeholder that can change).

Students are not required to know and recognize the formal terms "variable" and "algorithm."

CONTENT FOCUS

The focus is on students being able to define and identify variables as symbols with an understanding of how they are used in algorithms to store data.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

1. Extract common features from a set of interrelated processes or complex phenomena.

Strand	Algorithmic Thinking and Programming
Topic	**Control Structures**

ATP.CS.3.a Create a program using sequences, events, loops and conditionals to solve a problem.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students created a program that utilizes sequencing and loops. In grade 3, students build on their skills and knowledge to create programs with more refined strategies, such as loops and conditionals and consider the components of an event. In grade 4, students will continue to refine their programming skills using established structures, such as loops and conditionals.

IMPORTANT CONCEPTS

- Loops are statements that repeat and make programming more efficient for the computer and the programmer.
- Conditionals are typically in the form of "if/ then" statements and enable the program to follow different paths.
- Events are structures that programmers can use to explain how the program will react when the user interacts.
- Proper sequencing of steps within the program ensures efficiency.

KEY SKILL/PROCEDURES

- Insert a loop in a program to avoid typing a command several times.
- Insert a conditional in a program to create several paths (if/then).
- Create an event in the format "When (action), then (result) occurs."
- Diagram the flow of a program to demonstrate the sequence of events and products.
- Use statements that are introductory level (e.g., if/then, and/or).

Content Elaborations

CLARIFICATIONS

Loops can occur in programming by having the robot or pen repeat a motion several times, such as going forward ten paces and then turning thirty degrees. In an algorithm, students can program to have a number added several times.

Conditionals occur in a program by inserting a command to complete when a condition is met. For instance, if a condition states "If n=5," when the value n=5 is achieved, then the program will execute the command given.

Events can be thought of as an action because of an action such as, "When I click the mouse, the image rotates."

Strand	Algorithmic Thinking and Programming
Topic	**Control Structures**
	Sequencing of events and commands is an important part of programming when creating a program from scratch or remixing an existing one. Students can diagram or describe the steps of a program using a flowchart or other graphic organizer. **CONTENT FOCUS** Focus on students using a loop, conditional and/or event. Students should also diagram or describe the flow of a program. **COMPUTER SCIENCE PRACTICES** *Practice 4*. Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**

ATP.M.3.a Decompose (i.e., break down) the steps needed or not needed (i.e., abstraction) into precise sequences of instructions to design an algorithm.

Expectations for Learning

LEARNING PROGRESSION

ATP.M.3.a Decompose (break down) the steps needed or not needed (abstraction) into precise sequences of instructions to design an algorithm.

IMPORTANT CONCEPTS

- Modularity refers to smaller portions of a program that may complete their procedure. These modules (smaller portions) may be copied and used in other programs. A program can be decomposed to find its modules. These may be used in other programs.

KEY SKILL/PROCEDURES

- Utilize logical patterns of progression within an algorithm to make the best use of a series of steps.
- Utilize chunking strategies to group sets of a decomposed algorithm to modify the result of the algorithm.
- Recognize pseudocode and flow charts.

Content Elaborations

CLARIFICATIONS

Processes of logical thought should include the dissection of a whole into its parts. Solve smaller sections of a larger equation to determine its functionality toward the end goal. Chunking strategies help ensure that sets of instructions include all needed parts to reach the end goal. This can be written in code, pseudocode, real language or flowcharts.

CONTENT FOCUS

The focus is on students thinking logically as they work through an algorithm, determining if it should be decomposed, then breaking an algorithm into its smaller components and logically determining if an error has occurred somewhere within an algorithm.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**
	COMPUTER SCIENCE PRACTICES *Practice 3.* Recognizing and Defining Computational Problems 2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures. *Practice 4.* Developing and Using Abstractions 3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity. *Practice 7.* Communicating about Computing 1. Select, organize and interpret large data sets from multiple sources to support a claim.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**

ATP.PD.3.a Use a design process to plan the development of a program that solves problems.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students began to plan and sequentially create simple programs using graphic organizer tools. In grade 3, students use these skills to design and create programs to solve a problem. In grade 4, students will design programs that include the preferences of the end-user.

IMPORTANT CONCEPTS

- A flow chart is one type of organizational tool that can be used to plan a program considering the sequence of its features.
- An algorithm can be used to plan a program.

KEY SKILL/PROCEDURES

- Design a program that can solve a problem.
- Use the design process when planning a program.

Content Elaborations

CLARIFICATIONS

Programs can be designed in a plugged (i.e., using a computer) or unplugged environment (i.e., not using a computer).

Programs can be designed using a block-based environment.

Programs can address a one-step problem or a more complex one.

A flow chart is a type of organizational tool that can be used to plan a program.

The flow chart is a visual representation of decisions and directions throughout the program.

Students can design instructions for a simple game (e.g., tic-tac-toe).

CONTENT FOCUS

The focus is on designing a program that can solve a problem using one or two steps.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	COMPUTER SCIENCE PRACTICES *Practice 5.* Creating Computational Artifacts 1. Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, considering key features, time and resource constraints and user expectations. 2. Create a computational artifact for practical intent, personal expression or to address a societal issue.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**

ATP.PD.3.b Using a given program known to contain errors, identify and debug errors to ensure it works.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students described their problems and came up with possible solutions. In grade 3, guided questions will be asked to help students think more strategically about how to solve a problem in their program. In grade 4, students will continue with guided questions that assist them in debugging their program.

IMPORTANT CONCEPTS

- A computer bug is a series of commands that do not properly interact with each other and cause an interruption in the program execution (i.e., an error in the program).
- To "debug" is to find the error within a program and then apply an appropriate fix.

KEY SKILL/PROCEDURES

- Identify errors in a program.
- Apply a fix to errors in a program.

Content Elaborations

CLARIFICATIONS

If a program that is written will not execute properly, programmers often refer to the issue as the program "breaks" or the program has a "bug" (i.e., error). "Debugging" a program refers to scanning through the program code to find the error in the commands and then correcting or repairing that programming code.

Students might look at a set of instructions that are not in the correct order and determine the correct order to fix the debug "fix" the instructions.

Guided questions are questions that prompt the programmer to think more about their error and problem solve potential solutions without being given the answer.

CONTENT FOCUS

The focus is on locating, determining solutions and fixing errors in block-based through guided questioning.

COMPUTER SCIENCE PRACTICES

Practice 6. Testing and Refining Computational Artifacts

2. Identify and fix errors using a systematic process.

Strand	Artificial Intelligence
Topic	**Machine Learning**
AI.ML.3.a Label three different machine learning approaches to identify them to see different approaches.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 2, students used machine learning, classifiers and discussed how the machine knew what they were drawing. In grade 3, students label three different machine learning approaches. In grade 4, students will explain three different types of machine learning. **IMPORTANT CONCEPTS** • Approaches to machine learning include supervised learning, unsupervised learning and reinforcement learning. **KEY SKILLS/PROCEDURES** • Label types of machine learning to show various approaches to how machines learn. **Content Elaborations** **CLARIFICATIONS** Machine learning is the study of computer algorithms that improve automatically through experience. Applications range from data-mining programs that discover general rules in large data sets, to information filtering systems that automatically learn users' interests. **CONTENT FOCUS** There are different types of machine learning. **COMPUTER SCIENCE PRACTICES** *Practice 3.* Recognizing and Defining Computational Problems
AI.ML.3.b Give examples of bias to understand what it is and how it affects machine learning.	**Expectations for Learning** **LEARNING PROGRESSION** This concept is introduced in grade 3. In grade 4, students will explain how machine learning can create bias. **IMPORTANT CONCEPTS** • Identify what a bias is and how it can influence machine learning. **KEY SKILL/PROCEDURES** • Identify what a bias is to understand the concept and how it might affect machine learning.

Strand	Artificial Intelligence	
Topic	**Machine Learning**	
		Content Elaborations **CLARIFICATIONS** Bias can be found in all technology. It is based on the data sets used. **CONTENT FOCUS** Identifying bias in technology data sets. **COMPUTER SCIENCE PRACTICES** *Practice 3*. Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. 2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures. 3. Evaluate whether it is appropriate and feasible to solve a problem computationally.
AI.ML.3.c Identify tasks that use AI to perform human tasks to understand how humans rely on AI.		**Expectations for Learning** **LEARNING PROGRESSION** In grade 2, students listed attributions computers use for purposes of recognition. In grade 3, students identify tasks that use Artificial Intelligence (AI), the science and engineering of making intelligent machines and computer programs, to perform human tasks. In grade 4, students will describe tasks where AI can outperform humans on tasks. **IMPORTANT CONCEPTS** • AI can complete many human tasks. **KEY SKILLS/PROCEDURES** • Show that tasks that used to be done by humans can now be performed using AI to demonstrate how AI affects humans. **Content Elaborations** **CLARIFICATIONS** AI can perform tasks that humans once did. As AI grows, it can take over more human tasks; for example, self-driving cars and using a search engine versus looking in books. **CONTENT FOCUS** AI is a growing field that performs some human tasks.

Strand	Artificial Intelligence
Topic	**Machine Learning**
	COMPUTER SCIENCE PRACTICES *Practice 3.* Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. 2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures. 3. Evaluate whether it is appropriate and feasible to solve a problem computationally.

Strand	Artificial Intelligence
Topic	**Natural Interactions**
AI.NI.3.a Locate AI systems that are designed to help everyone have equal access.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 2, students identified Artificial Intelligence (AI) applications. In grade 3, students locate AI systems that are designed for accessibility. In grade 4, students will use AI systems that are meant to be more inclusive and how it affects the way humans use the systems. **IMPORTANT CONCEPTS** • AI systems can create equal access. **KEY SKILLS/PROCEDURES** • List ways in which AI makes it more inclusive to promote equity. **Content Elaborations** **CLARIFICATIONS** AI systems include adaptive tools like text to speech, speech to text and translation programs. **CONTENT FOCUS** AI can assist in helping everyone to be included. **COMPUTER SCIENCE PRACTICES** *Practice 3.* Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. 2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures. 3. Evaluate whether it is appropriate and feasible to solve a problem computationally.

Strand	Artificial Intelligence
Topic	**Perception**

AI.P.3.a Use different sensors, analog and digital, and discuss the difference between them.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students will be able to tell about sensors and their relation to their function. In grade 3, students use different sensors to evaluate the differences between them. In grade 4, they will understand the difference between analog and digital and how they can be used.

IMPORTANT CONCEPTS

- Students should know what types of sensors do and how they are similar and different from other sensors.

KEY SKILLS/PROCEDURES

- Recognize the difference between analog and digital sensors.
- Explain how different sensors gather data.
- Explain the differences between analog sensors including accelerometers, light sensors, sound sensors, pressure sensors, analog temperature sensors and digital sensors which consist of three components, a sensor, cable and transmitter.
- In digital sensors, the signal measured is directly converted into digital signal output inside the digital sensor itself.

Content Elaborations

CLARIFICATIONS

Recognize the difference between analog and digital clocks and thermometers. Discuss how these sensors are similar and different.

CONTENT FOCUS

There are two basic ways sensors gather data: analog and digital.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.
3. Evaluate whether it is appropriate and feasible to solve a problem computationally.

Strand	Artificial Intelligence
Topic	**Perception**

AI.P.3.b Describe what computer perception is and how it affects computers to see how it compares to human perception.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students used intelligent agents to assist in research. In grade 3, students describe what computer perception is. In grade 4, students will give examples of how computer perception is affected by the environment.

IMPORTANT CONCEPTS

- Compare human and computer perception to show the differences.

KEY SKILLS/PROCEDURES

- Compare how humans use their senses to gather data about the world around them and computers use sensors to gather and interpret data.

Content Elaborations

CLARIFICATIONS

Comparison of input (how cold or hot) is determined by a human versus how a computer can tell if something is hot or cold.

CONTENT FOCUS

There are similiarities and differences between human sensors and computer sensors.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.
3. Evaluate whether it is appropriate and feasible to solve a problem computationally.

Strand	Artificial Intelligence
Topic	**Representation & Reasoning**
AI.RR.3.a With guidance and support, create a classification system using a tree structure to understand how computers think.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 2, students created simple decision trees. In grade 3, students create a classification system using a tree structure. In grade 4, students will create a tree structure to understand binary solutions. **IMPORTANT CONCEPTS** • Explore the tree structure to examine the process of making decisions. **KEY SKILLS/PROCEDURES** • Use a flowchart to show the decision-making process. **Content Elaborations** **CLARIFICATIONS** Decision trees in artificial intelligence are used to arrive at conclusions based on the data available from decisions made in the past. **CONTENT FOCUS** Decision trees help make decisions through machine learning. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena. 2. Evaluate existing technological functionalities and incorporate them into new designs. 3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity. 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Strand	Artificial Intelligence
Topic	**Representation & Reasoning**

AI.RR.3.b Use AI to answer questions and describe how the answer is reasonable.

Expectations for Learning

LEARNING PROGRESSION
This concept was introduced in grade 3. In grade 4, students will describe how Artificial Intelligence (AI) uses knowledge to make a reasonable answer.

IMPORTANT CONCEPTS
- AI gives a reasonable answer based on programming and input.

KEY SKILLS/PROCEDURES
- Create a sentence using words with multiple meanings to see how the AI defines the words.
  - For example, the word pitcher could mean a baseball player or a container that holds water.

Content Elaborations

CLARIFICATIONS
Students learn concepts, such as how the computer knows the difference between words with similar sounds or spellings.

CONTENT FOCUS
AI is complex and has to make lots of decisions to differentiate between multiple meanings.

COMPUTER SCIENCE PRACTICES
Practice 4. Developing and Using Abstractions
1. Extract common features from a set of interrelated processes or complex phenomena.
2. Evaluate existing technological functionalities and incorporate them into new designs.
3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Strand	Artificial Intelligence
Topic	**Societal Impacts**
AI.SI.3.a Define what a bias is to understand how it can influence humans.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 2 students discussed if Artificial Intelligence (AI) was good or bad. In grade 3, students define bias and begin to understand how it can influence humans. In grade 4 students will give examples of bias and how it affects decision making. **IMPORTANT CONCEPTS** • Define bias as it pertains to artificial intelligence. **KEY SKILLS/PROCEDURES** • Illustrate the definition of bias and its connection to AI. • Explain how AI bias influences humans. **Content Elaborations** **CLARIFICATIONS** Bias is human nature and can have varied consequences. **CONTENT FOCUS** Bias is a human trait and can relate to AI. **COMPUTER SCIENCE PRACTICES** *Practice 3.* Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. 2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures. 3. Evaluate whether it is appropriate and feasible to solve a problem computationally.

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.3.a Identify computing technologies that have changed the world and express how those technologies influence and are influenced by cultural practice.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students compared and contrasted how technology use has changed and the impact it has had on their personal lives. In grade 3, students identify the impact technology has on everyday life in the local community. In grade 4, students will recognize the impact of technology on the global community.

IMPORTANT CONCEPTS

- People within a local community use technology in various ways.
- Daily life is influenced by the technology in a community.

KEY SKILL/PROCEDURES

- Identify specific types of technology used in the local community.
- Describe ways that various technology resources impact daily life in a local community.

Content Elaborations

CLARIFICATIONS

New computing technology is created, and existing technologies are modified for many reasons, including to increase their benefits, decrease their risks and meet societal needs. Students explore topics that relate to the history of technology and the changes in the world due to technology. Topics could be based on current news content, such as robotics, wireless internet, mobile computing devices, GPS systems, wearable computing or ways social media has influenced social and political changes. (CSTA K-12 Computer Science Standards, 2017)

CONTENT FOCUS

The focus is on the impacts of technology on the local community.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

1. Include the unique perspective of others and reflect on one's perspectives when designing and developing computational products.

Strand	Impacts of Computing
Topic	**Culture**
	Career Connections **CAREER AWARENESS** Using a resource such as Smithsonian Institute, students learn about computing technologies from the past. Students choose one type of technology to research to see how it has changed society and how people work. Students create an artifact such as a timeline or presentation to share their findings.

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.3.b Identify how computing devices have built-in features to increase accessibility to all users.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students compared and contrasted how technology use has changed and the impact it has had on their personal lives. In grade 3, students identify diverse user needs and how computing devices have features built in to increase accessibility. In grade 4, students will identify and anticipate diverse needs and ways to improve devices to make them more accessible to users.

IMPORTANT CONCEPTS

- Users have diverse needs that impact accessibility.
- Computing devices have built-in features to increase accessibility for all users.

KEY SKILL/PROCEDURES

- Identify built-in features to increase accessibility.
- Recognize that users have diverse needs.

Content Elaborations

CLARIFICATIONS

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. Examples of built-in features to increase accessibility include voice command, text-to-speech and magnify text.

CONTENT FOCUS

The focus is on the diverse needs of users and how those needs impact accessibility.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

2. Address the needs of diverse end-users during the design process to produce artifacts with broad accessibility and usability.

Strand	Impacts of Computing
Topic	**Social Interactions**

IC.SI.3.a Collaborate and consider diverse perspectives to improve digital artifacts.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students were able to compare and contrast safe and responsible technology behaviors. In grade 3, students collaborate through feedback and reflection to improve a digital artifact and begin to explore how diverse perspectives improve artifacts. In grade 4, students will collaborate with others to share the workload and increase diverse perspectives to improve a digital artifact.

IMPORTANT CONCEPTS

- Collaborating with peers to include diverse perspectives can improve digital artifacts.
- Reflecting on feedback from others can improve digital artifacts.
- Providing feedback to others can help to improve the quality of their work.

KEY SKILL/PROCEDURES

- Leave thoughtful feedback for peers that will help improve their digital artifacts.
- Reflect on feedback from peers to improve digital artifacts.

Content Elaborations

CLARIFICATIONS

Teachers can support students to leave thoughtful feedback by modeling this process. Teachers should conduct whole group discussions after students have left feedback to determine if the feedback was productive.

CONTENT FOCUS

The focus is on providing and reflecting on feedback to improve digital artifacts.

COMPUTER SCIENCE PRACTICES

Practice 2. Collaborating Around Computing

1. Cultivate working relationships with individuals possessing diverse perspectives, skills and personalities.
2. Create team norms, expectations and equitable workloads to increase efficiency and effectiveness.
3. Solicit and incorporate feedback from and provide constructive feedback to team members and other stakeholders.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**

IC.SLE.3.a Use public domain or Creative Commons media, and refrain from copying or using material created by others without permission.

Expectations for Learning

LEARNING PROGRESSION

In K-2, students were able to explain why it is important to use technology in the correct way to make decisions about appropriate use and protecting login information. In grade 3, students are introduced to the concept that some resources can be shared (e.g., public domain, Creative Commons) while others must be used only with proper citations or permission. In grade 4, students will be introduced to formal procedures used when sharing materials. Students will be expected to identify the type of source and give credit to the source.

IMPORTANT CONCEPTS

- Certain resources can be shared freely; some resources can be shared with proper citation and others can only be shared with permission from the creator.

KEY SKILL/PROCEDURES

- Determine whether a source can or cannot be used freely.
- Express where online resources are found.

Content Elaborations

CLARIFICATIONS

Ethical complications arise from the opportunities provided by computing. The ease of sending and receiving copies of media on the internet (e.g., video, photos, music) creates the opportunity for unauthorized use, such as online piracy, and disregard of copyrights. Students should consider the licenses on computational artifacts that they wish to use. For example, the license on a downloaded image or audio file may have restrictions that prohibit modification, require attribution, or prohibit use entirely. (CSTA K-12 Computer Science Standards, 2017)

CONTENT FOCUS

The focus is on recognizing that some resources are public domain and can be used freely and other materials need to be cited properly.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating about Computing

3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**

IC.SLE.3.b Determine whether information should be shared or kept private to protect student identity.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students have learned how to use the internet responsibly. In grade 3, students learn the importance of keeping personal information secure. In grade 4, students will start to make distinctions between what information should be shared and what information should be kept private.

IMPORTANT CONCEPTS

- For safety and security, personal information should be kept private.

KEY SKILL/PROCEDURES

- Determine whether information should or should not be shared digitally.
- Recognize that keeping information private protects your identity.

Content Elaborations

CLARIFICATIONS

Examples of information to be kept private are first and last name, birthday, addresses, phone numbers or other personal identifiers. Students should also understand that they should not share the personal information of others.

CONTENT FOCUS

The focus is on knowing the difference between information that can be shared and information that should be kept private.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating about Computing

2. Describe, justify and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**

IC.SLE.3.c Communicate the importance of information security to protect one's own digital footprint.

Expectations for Learning

LEARNING PROGRESSION

In grade 2, students have learned how to use the internet responsibly. In grade 3, information security and the concept of a digital footprint are introduced. In grade 4, students will spend time considering their digital footprint and the impact of their decisions.

IMPORTANT CONCEPTS

- Every person has a digital footprint that includes all aspects of their online behavior.
- Keeping information secure is important to consider when using the internet.

KEY SKILL/PROCEDURES

- Define digital footprint and give examples of online activity that contributes to a person's digital footprint.
- Communicate examples of ways to keep information secure (e.g., not staying logged into public computers, not sharing passwords, not sharing personal information online).

Content Elaborations

CLARIFICATIONS

At grade 3, the term "digital footprint" is first introduced. While making personal connections to this term is encouraged, instruction should be more focused on understanding what information should and should not be shared and how this impacts a person.

CONTENT FOCUS

The focus is on understanding what should be shared online and the effect of sharing different types of information.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating about Computing

2. Describe, justify and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**

IC.SLE.3.d Explain why different types of information might need to be protected, describing common safeguards for protecting personal information.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students will learn about what information should be shared and how to keep their information secure. In grade 4, students are introduced to the idea that there are tradeoffs between allowing information to be public versus keeping information private. In grade 5, students will learn about their digital footprint.

IMPORTANT CONCEPTS

- Students should be able to define personally identifiable information (PII).
- Individuals should be careful what personally identifiable information (PII) they share online or in-person.

KEY SKILLS/PROCEDURES

- List examples of personally identifiable information (PII).
- Explain the dangers of sharing personally identifiable information.

Content Elaborations

CLARIFICATIONS

At this level, student discussions focus on examples of personally identifiable information and how to keep personal information, including private and public information, safe online.

CONTENT FOCUS

Research and describe the potential effects of the positives and negatives of making the information public.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems.

2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.

Practice 6. Testing and Refining Computational Artifacts.

1. Systematically test computational artifacts by considering all scenarios and using test cases.