Ohio's Standards and Model Curriculum

Computer Science

DECEMBER 2018

Ohio | Department of Education

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Introduction to Ohio's Learning Standards for Computer Science

Substitute House Bill Number 170 took effect in March 2018, requiring the State Board of Education of Ohio to adopt standards and a model curriculum for grade K-12 instruction in computer science. A team of Ohio educators came together to develop and write the computer science standards and model curriculum, and the State Board adopted these in December 2018.

Ohio's Standards in Computer Science are fully aligned to Ohio's five-year strategic plan for education, *Each Child, Our Future*. The strategic plan acknowledges a major education policy shift around technology. A student's ability to use technology strategically is now identified as foundational and just as important as mathematics and English language arts, from which all other learning is built.

GUIDING ASSUMPTIONS

The team of Ohio educators that developed the standards and model curriculum had a clear goal – to encourage districts and educators to give all Ohio students opportunities to learn computer science. Beginning in the earliest grades and continuing through grade 12, Ohio's students will develop a foundation of computer science knowledge and gain experiences in computational thinking and problem solving to become creators and innovators of computing technology. Ohio's Computer Science Standards and Model Curriculum will give students experiences that help them discover and take part in a world continually influenced by technology and to understand the role of computing in that world.

OVERVIEW OF THE COMPUTER SCIENCE STANDARDS CONTENT

The standards will support a progression of learning in each core concept or strand to provide computer science experiences for all Ohio students. The K-8 standards integrate computer science into instruction across subject areas including mathematics, science, history, English language arts, fine arts, world language and career and technology courses. The high school computer science standards provide both foundational and advanced opportunities districts can use to design as separate courses or, when appropriate, integrate into other disciplines.

Ohio's Computer Science Standards and Model Curriculum are organized in the following strands:

- **Computing Systems** - Addresses how devices, including hardware and software, interact to accomplish tasks and how students can troubleshoot computing systems when they do not work as intended.
- **Networks and the Internet** - Addresses how networks connect to share information and resources and how students can apply cybersecurity concepts to protect information.
- **Data and Analysis** - Addresses how data can be collected and stored; analyzed and communicated; and used to make more accurate predictions.
- **Algorithmic Thinking and Programming** - Addresses program development, including the use of algorithms, variables, control structures and modules.
- **Impacts of Computing** – Addresses computing's influence on our world by examining the relationship between computing and culture, computing's impact on social interaction, and legal and ethical implications of computing.

Computational Thinking is a problem-solving process that students use to engage with concepts in the computer science standards. This thinking involves formulating problems in a way that can be carried out by a computer. Using computational thinking to solve a problem includes breaking down the problem into manageable parts; recognizing patterns; excluding irrelevant details to abstract or identify general principles that generate these patterns; and developing step-by-step sequences or algorithms to solve the problem and similar problems. Computational thinking can be applied with or without computers, for example, through "unplugged" activities. While computational thinking is a focus in computer science, it also is used in content areas beyond computer science.

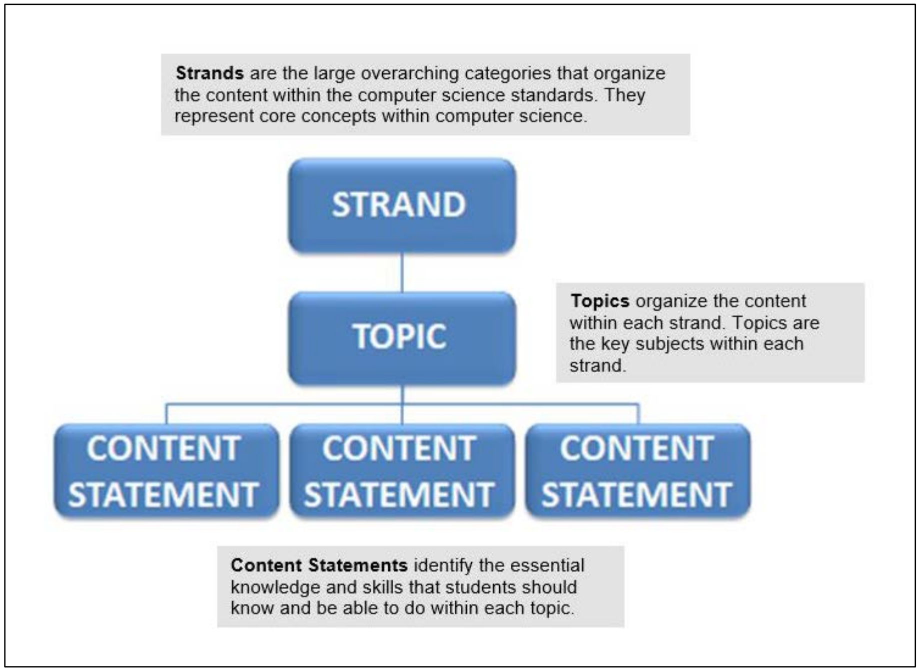
It is important that computer science not be confused with other aspects and uses of computer technology in schools, including:

- **Computer literacy "**refers to the general use of computers and programs, such as productivity software." Examples of computer literacy include performing an internet search and creating a digital presentation.
- **Educational (computer) technology "**applies computer literacy to school subjects. For example, students in an English class can use a web-based application to collaboratively create, edit and store an essay online."
- **Digital citizenship "**refers to the appropriate and responsible use of technology, such as choosing an appropriate password and keeping it secure."
- **Information technology "**often overlaps with computer science but is mainly focused on industrial applications of computer science, such as installing [and operating] software rather than creating it. Information technology professionals often have a background in computer science."

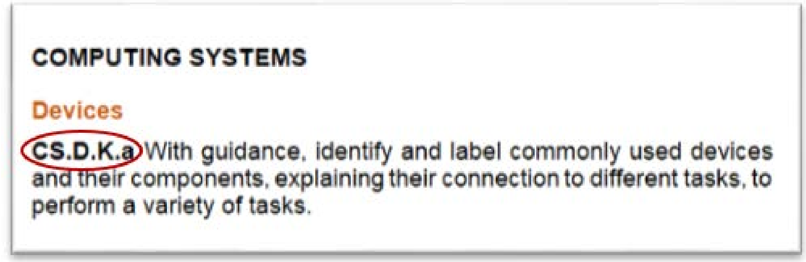
  (K-12 Computer Science Framework, 2016, pp.13-14)

OVERVIEW OF THE COMPUTER SCIENCE STANDARDS FRAMEWORK

Ohio's Computer Science Standards are organized by strands, topics and content statements.



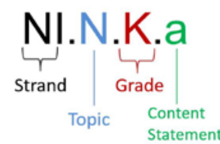
Kindergarten through Grade 8 - Content statements are organized *by grade level*. Below is an example of a content statement for kindergarten and its corresponding content statement code. This content statement addresses the topic of *Devices* within the *Computing Systems* strand.



COMPUTING SYSTEMS

Devices

CS.D.K.a With guidance, identify and label commonly used devices and their components, explaining their connection to different tasks, to perform a variety of tasks.

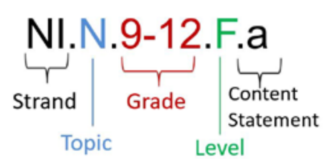


Grades 9-12 - Content statements are organized *by grade band* into *two levels – Foundational and Advanced*. See an example of a content statement for high school and its corresponding content statement code below. This content statement addresses the topic of *Networking* within the *Networks and the Internet* strand, at the Foundational Level.

NETWORKS AND THE INTERNET

Networking

NI.N.9-12.F.a Evaluate and select networking devices to establish scalable communications.



Equity and Computer Science[1]

COMPUTER SCIENCE FOR ALL

To help realize the vision *of computer science for all students,* equity must be at the forefront of the state's efforts to implement the computer science standards. *Equity is more than whether classes are available. It includes how those classes are taught, how students are recruited and how the classroom culture supports diverse learners and promotes retention***.** When equity exists, schools expect academic success for every student and makes that success accessible to every student. The result of such equity is a classroom of diverse students based on factors such as race, gender, disability, socioeconomic status and English language proficiency. All these students have high expectations and feel empowered to learn.

Computer science faces intense challenges related to access, opportunity and culture.

- The 2015 National Assessment of Educational Progress (NAEP) survey showed that only 44 percent of 12th grade students attend high schools that offer any computer science courses (Change the Equation, 2016). This data showed that students with the least access are Black, Latino and Native American; from lower income backgrounds; and from rural areas.

Even when computer science courses are available, there are wide gaps in participation and the level of instruction.

- For the 2015 Advanced Placement (AP) Computer Science exam, only 21.9 percent of students were female, 3.9 percent were Black or African American, 9 percent were Hispanic or Latino and 0.4 percent were American Indian (College Board, 2016). The potential impact of these gaps in participation is illustrated in the statistic that females who take high school AP Computer Science are 10 times more likely to major in computer science in college than students who do not take this course. Similarly, African American students are seven times more likely, and Hispanic students 8.5 times more likely, to major in computer science when they have taken high school AP Computer Science (Morgan & Klaric, 2007).
- Especially in schools with large numbers of African American and Latino students, computer classes too commonly offer only basic, rudimentary user skills rather than engaging students in the problem-solving and computational thinking practices that form the foundation of computer science (Margolis et al., 2012).

The lack of representation in computer science after K–12 reflects the lack of access and participation in grades K–12. In 2015, only 24.7 percent of workers employed in computer and mathematical occupations were female. Only 8.6 percent were Black or African American, and only 6.8 percent were Hispanic or Latino (Bureau of Labor Statistics, 2015).

EFFORTS TO INCREASE EQUITY

Even when schools have made computer science courses available to students, inequity can be perpetuated at the classroom level. Educators can work to ensure equity through changes in curriculum, instruction and classroom culture.

- Educators can reach *students with disabilities* using learning accommodations, curricular modifications and established techniques for differentiated instruction. For example, the Quorum programming language accommodates students with visual impairments by enabling the programming language to be read by computer screen readers (Quorum, 2019). Recent research shows ways to use Universal Design for Learning (UDL) to develop and refine introductory computer science experiences for a wider range of learners (Hansen et al., 2016). Educators also can apply instructional strategies used in other content areas to support struggling learners and students with disabilities. For example, if verbal prompting helps in math instruction, it will likely help in computer science instruction (Snodgrass, Israel, & Reese, 2016).

[1] The "Equity and Computer Science" section has been modified from chapter two of The K-12 Computer Science Framework, "Equity in Computer Science Education." (K–12 Computer Science Framework. (2016). Retrieved from http://www.k12cs.org.) This work is licensed under Creative Commons (CC BY-NC-SA 4.0).

- A variety of approaches make programming more accessible *to young learners and beginners.* Visual, block-based programming languages allow students to program without the obstacle of syntax errors (errors in typing commands) found in traditional text-based languages. Programming environments on tablets have made programming even more accessible to younger children by reducing the number of available commands and the amount of reading required to navigate the options (Strawhacker & Bers, 2014).
- To address a *lack of computer and internet access*, educators can help students learn many computer science topics, such as algorithmic thinking, searching, sorting and logic through "unplugged" activities.
- To reach *females and underrepresented minorities*, teachers can use strategies to work against issues such as the threat of stereotyping or bias. For example, stereotype threats can be mitigated by altering the wording of test questions to be gender-neutral and using examples that are equally relevant to both males and females (Kumar, 2012). It also is important for students to have diverse role models in the field so they can imagine themselves as a computer scientist. Role models also help dispel stereotypes of how computer scientists look and act (Goode, 2008).

Below, are other practices that teachers can adopt and adapt to change classroom culture and broaden participation in computer science:

- Connect computer science to concepts that motivate children, like fairness and social justice (Denner et al., 2015).
- Practice culturally relevant pedagogy to tie computer science to students' experiences, culture and interests (Margolis et al., 2014). Designing projects and instruction to be socially relevant and meaningful for diverse students helps them "build personal relationships with CS concepts and applications -- an important process for discovering the relevance of CS for their own lives." (Margolis et. al, 2012, p. 76)
- Reflect on beliefs and actions to address stereotypes among students and teachers (Margolis et al., 2014).

EQUITY AND THE COMPUTER SCIENCE STANDARDS

The computer science standards reflect the writing team's considerations on equity. The standards describe concepts and skills all students can benefit from, regardless of whether they go on to postsecondary computer-science education or a career in computer science.

Equity is woven into the computer science concepts and skills across grade levels. This is especially apparent in the core concept or strand involving *Impacts of Computing*. Here, students examine the social implications of the digital world, including their impacts on equity and access to computing. Specific content statements address equity directly. For example, in grade 3, students identify diverse user needs and "how computing devices have built-in features to increase accessibility to all users." In grade 7, students "evaluate various technologies to identify issues of bias and accessibility." Students in grade 8 build on prior learning to work against existing inequities; they propose guidelines "to positively impact bias and accessibility in the design of future technologies."

As students design computational products, they engage in computer science practices that also directly involve consideration of equity, inclusion and diversity. Students foster inclusion as they develop products that "include the unique perspectives of others" and "address the needs of diverse end users." Students encourage diversity through working in teams "with individuals possessing diverse perspectives." Involving students in such practices stresses the need to practice equity when doing computer science. Through such practices, students can see the benefit of, for example, considering the products they develop from the perspectives of a diverse group of end-users, such as those with visual impairments and English language learners.

Ohio's Model Curriculum & Instructional Supports for Computer Science

OVERVIEW OF THE MODEL CURRICULUM

The purpose of the model curriculum is to provide clarity on Ohio's Computer Science Standards and set the foundation for planning and developing instruction to implement these standards. The model curriculum reflects the expertise of Ohio educators. It is not a collection of lessons or a full curriculum. It does not suggest pace, sequence or the amount of time teachers should spend on topics.

The model curriculum contains two sections: **Expectations for Learning** and **Content Elaborations.**

Expectations for Learning

LEARNING PROGRESSION

Explains the position of the content statement within its respective learning progression, including previous and future learning

IMPORTANT CONCEPT

Identifies important concepts students should develop

KEY SKILL/PROCEDURES

Identifies key skills and procedures students should know and demonstrate

Information about learning progressions, important concepts and key skills and procedures clarifies the expectations for student learning and guides teachers in developing lessons and assessments, both formative and summative.

Content Elaborations

CLARIFICATIONS

Provides clarification of the content

CONTENT FOCUS

Identifies the aspects of the content that teachers should stress with their students

COMPUTER SCIENCE PRACTICES

Identifies connections to the **Computer Science Practices** that describe the behaviors and ways of thinking that computationally literate students use to engage in their technological world (K-12 Computer Science Framework)

OVERVIEW OF THE INSTRUCTIONAL SUPPORTS

The Instructional Supports section offers instructional strategies and resources that target specific content statements. The Department will continue to add supports to this section over time.

This section includes descriptive examples of instructional strategies. Supports also identify connections to other content statements in computer science and across content areas, as well as connections to careers, to help teachers plan instruction and incorporate computer science content into their curricula. Other supports woven throughout this section include descriptions of common misconceptions and ways to structure computer science experiences that are equitable and accessible to all students.

Grades K-2

KINDERGARTEN

Strand	Computing Systems
Topic	**Devices**
CS.D.K.a With guidance, identify and label commonly used devices and their components, explaining their connection to different tasks, to perform a variety of tasks.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, with guidance, students name and use common devices and their components to perform a variety of tasks. In grade 1, students will begin operating the devices independently. **IMPORTANT CONCEPTS** • Every device has a unique identifier • Different devices perform different tasks **KEY SKILL/PROCEDURES** • With guidance, name devices used by students and their components **Content Elaborations** **CLARIFICATIONS** Students will name devices' main components (e.g., tablet, computer, monitor, mouse, printer) and explain the connection between device components and different tasks. They will recognize and name software. **CONTENT FOCUS** The focus is on identifying devices and using correct terminology for hardware and software. **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	Computing Systems
Topic	**Hardware/Software**
CS.HS.K.a With guidance and support, identify and use hardware and software necessary for accomplishing a task.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, with teacher support, students name and use hardware and software to perform functions. In grade 1, students will begin comparing hardware and software and their functions. **IMPORTANT CONCEPTS** • Hardware and software identification and the function they perform **KEY SKILL/PROCEDURES** • With guidance and support, identify the differences between hardware and software, their functions and purpose **Content Elaborations** **CLARIFICATIONS** Students will classify and sort hardware and software. They will label software and hardware and their functions. **CONTENT FOCUS** The focus is on the identification of hardware and software and their function. **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	Computing Systems
Topic	**Troubleshooting**
CS.T.K.a With guidance and support, use problem solving strategies to troubleshoot a problem.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, with teacher support, students use a problem-solving process to identify problems and begin troubleshooting. In grade 1, they will continue using a problem-solving process. **IMPORTANT CONCEPTS** • There are a variety of problem solving processes. A problem-solving process typically includes identifying the problem, brainstorming solutions, making a plan, testing solutions, and revising **KEY SKILL/PROCEDURES** • With guidance and support, apply a problem-solving process, using appropriate terminology to solve a problem **Content Elaborations** **CLARIFICATIONS** Students will identify problems (e.g., left click or right click, no audio, no power, navigating windows) and attempt to solve them using a problem-solving process. **CONTENT FOCUS** The focus is on solving a problem using a problem-solving process. **COMPUTER SCIENCE PRACTICES** *Practice 6.* Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process. *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	Networks and the Internet
Topic	**Networking**
NI.N.K.a With guidance and support, create a list of ways information can be shared electronically to gain a deeper understanding of how information is transmitted (e.g., email, social media).	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students are introduced to the idea of what a network is and how people use it. In grade 1, students will begin to develop an understanding of concepts of networking and of unique identifiers within a global community. They will also begin to develop an understanding of what devices people use to network and how each device people network with has a unique identifier. In addition, students will recognize that the computing devices with unique identifiers can be connected together to access and retrieve information. **IMPORTANT CONCEPTS** • Users of the internet communicate with a global community • A variety of information can be communicated electronically **KEY SKILL/PROCEDURES** • Identify communications that can be transmitted electronically with guidance **Content Elaborations** **CLARIFICATIONS** The internet is global. Students will identify the devices we use to communicate using the internet. **CONTENT FOCUS** The focus is on introducing students to networks and electronic communication. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. *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	Networks and the Internet
Topic	**Cybersecurity**
NI.C.K.a With guidance and support, identify and use secure practices (e.g., passwords) to protect private information.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten through grade 2, students work on being able to explain why it is important to use technology in a responsible way in order to make decisions about its use. Students also work to demonstrate how to use technology appropriately and safely and how to protect login information. **IMPORTANT CONCEPTS** • Decision making when using technology **KEY SKILL/PROCEDURES** • With guidance and support, create and use passwords appropriately • With guidance and support, log in and out of apps and devices **Content Elaborations** **CLARIFICATIONS** Realize that kindergartners require assistance with their passwords initially. Focus on the importance of passwords staying in the classroom. This provides peer assistance with passwords, but allows the teacher to focus on the importance of not sharing passwords. **CONTENT FOCUS** The focus is on using passwords and devices appropriately. **COMPUTER SCIENCE PRACTICES** *Practice 7.* Communicating About Computing 3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

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

DA.DCS.K.a Identify data to collect and sort.

DA.DCS.K.b With guidance and support, demonstrate how data can be collected and stored in a variety of ways.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, students develop an understanding of what data is. With teacher support, students collect and sort data using a variety of methods. In grade 1, students will begin storing and retrieving data.

IMPORTANT CONCEPTS

- Data is information. When using technology, data is often quantities, characters, or symbols that are the inputs and outputs of computer programs (see Code.org).
- Data can be collected and represented in a variety of ways

KEY SKILL/PROCEDURES

- Identify what data is
- With guidance and support, sort data in multiple ways (e.g., paper pencil)
- With guidance and support, represent data through a variety of media

Content Elaborations

CLARIFICATIONS

Students can address this content with or without a computing device.

A variety of media would include paper pencil, manipulatives and physical models.

CONTENT FOCUS

The focus is on data identification, collection and organization.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

2. Evaluate existing technological functionalities and incorporate them into new designs.

Strand	Data and Analysis
Topic	**Visualization and Communication**
DA.VC.K.a With guidance, organize and present data in various formats to make observations.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students are presenting data in various formats. In grade 1, they will continue presenting data in various formats. **IMPORTANT CONCEPTS** • Data can be sorted by attributes • Data can be presented in a variety of formats **KEY SKILL/PROCEDURES** • Sort data by different attributes • Describe attributes of data • Explain sorting to peers **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. Kindergarteners are working with physical objects and concrete manipulatives. Various formats can include: • graphic organizers • categorical sort • modeling • drawings • sorting by different attributes **CONTENT FOCUS** The focus is on representation of data.

Strand	Data and Analysis
Topic	**Visualization and Communication**

	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, taking into account key features, time and resource constraints, and user experience. 2. Create a computational artifact for practical intent, personal expression, or to address a societal issue. 3. Modify an existing artifact to improve or customize it. *Practice 7.* Communicating About Computing 1. Select, organize, and interpret large data sets from multiple sources to support a claim. 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Strand	Data and Analysis
Topic	**Inference & Modeling**
DA.IM.K.a With guidance, create a model of an object or process to identify patterns.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students are modeling data and identifying patterns with guidance. In grade 1, students will continue to model data and identify patterns and begin explaining their model. **IMPORTANT CONCEPTS** • Data can be represented through modeling • Patterns within the data can be discovered **KEY SKILL/PROCEDURES** • With guidance, model data to discover and identify patterns **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. Students model data through representation data visually, although not necessarily using paper and pencil as in graphs. Data can be modeled using manipulatives and physical models. **CONTENT FOCUS** The focus is on modeling data and simple pattern detection. **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, taking into account key features, time and resource constraints, and user experience. 2. Create a computational artifact for practical intent, personal expression, or to address a societal issue. 3. Modify an existing artifact to improve or customize it. *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases.

Strand	Data and Analysis
Topic	**Inference & Modeling**
	Practice 7. Communicating About Computing 1. Select, organize, and interpret large data sets from multiple sources to support a claim. 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**

ATP.A.K.a With guidance and support, model a real-world process by constructing and following step-by-step directions (i.e, algorithms) to complete tasks.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, with teacher support, students will construct and/or follow directions to complete a task in a real-world context verbally and pictorially. In grade 1, students will construct and follow directions through pictures and words.

IMPORTANT CONCEPTS

- Step by step directions can be constructed to complete a real-world task
- Directions can be given verbally or visually

KEY SKILL/PROCEDURES

- With guidance and support, construct and complete a verbal and/or visual task with two steps

Content Elaborations

CLARIFICATIONS

Students will listen to directions to complete a task. Students should express steps verbally or through pictures. During the learning process, students will understand that steps (i.e., algorithms) are required in various processes in their daily lives. Algorithms are commonly implemented using a precise language that computers can interpret.

CONTENT FOCUS

The focus is on three-step directions and the sequence of steps to complete a task.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Practice 6. Testing and Refining Computational Artifacts
2. Identify and fix errors using a systematic process.

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	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**
ATP.VDR.K.a Recognize that a group of items (e.g., numbers, symbols or pictures) can be used to represent data.	## Expectations for Learning **LEARNING PROGRESSION** In kindergarten, students recognize that numbers, symbols and pictures represent information. In grade 1, students will use numbers, symbols and pictures to represent information. **IMPORTANT CONCEPTS** • Numbers, symbols and/or pictures can be recognized as a representation of information **KEY SKILL/PROCEDURES** • Interchange information with a number, symbol or picture ## Content Elaborations **CLARIFICATIONS** Information in the real world can be represented in computer programs. (K-12 Computer Science Framework, 2016) Recognize that attributes can be used to identify information and interchange them with numbers, symbols, or pictures. **CONTENT FOCUS** The focus is on representing data using numbers, symbols, and/or pictures. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *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	Algorithmic Thinking and Programming
Topic	**Control Structures**
ATP.CS.K.a With guidance and support, model a sequence of instructions (i.e., program) with a beginning, middle and end to solve a problem or express an idea.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, with teacher support, students model simple sequences and order steps of a sequence to solve a problem or express an idea. In grade 1, with guidance, students will extend their experiences with sequencing to involve loops (i.e., repetition) within their sequence. **IMPORTANT CONCEPTS** • An algorithm is a sequence of steps. • Programs may be modeled to express an idea or solve a problem. **KEY SKILL/PROCEDURES** • With guidance and support, model sequences to follow at least a three-step process (e.g., beginning, middle, end) **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. Sequences should be in logical order: beginning, middle and end. Modeling can be done visually or verbally. **CONTENT FOCUS** The focus is on sequencing, process (i.e., steps), and problem solving. **COMPUTER SCIENCE PRACTICES** *Practice 4*. Developing and Using Abstractions 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *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	Algorithmic Thinking and Programming
Topic	**Program Development**

ATP.PD.K.a With guidance and support, plan or create an artifact to illustrate thoughts, ideas and problems in a sequential (step-by-step) manner (e.g., story map, storyboard, sequential graphic organizer).

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, with teacher support students plan and/or create an artifact to illustrate thoughts, ideas, and problems in a sequential manner. In grade 1, with guidance, students will continue to plan and create, as well as begin to debug an artifact in order to illustrate thoughts, ideas, and problems in a sequential manner.

IMPORTANT CONCEPTS

- Artifacts illustrate thoughts, ideas and problems in a sequential manner

KEY SKILL/PROCEDURES

- With guidance and support, plan and create an artifact to illustrate thoughts, ideas and problems in a sequential manner

Content Elaborations

CLARIFICATIONS

An artifact is anything created by a human. An artifact could be a visual program, story map, story board or sequential graphic organizer.

CONTENT FOCUS

The focus is on creating artifacts and programs.

COMPUTER SCIENCE PRACTICES

Practice 5. Creating a Computational Artifact
1. Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, taking into account 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.

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	**Culture**
IC.Cu.K.a With guidance and support, identify technologies that impact one's own everyday life. **IC.Cu.K.b** With guidance and support, recognize different ways computing devices are used regularly to understand technology's impact on one's own daily life.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students identify what technology is and how it has changed and impacted their lives. In grade 1, they will recognize the different ways technology impacts and the role technology plays in their lives. **IMPORTANT CONCEPTS** • Technology can be unplugged or plugged • Technology is constantly changing and affects how we live **KEY SKILL/PROCEDURES** • With guidance and support, identify technology in their lives • With guidance and support, explain how the technology impacts their life **Content Elaborations** **CLARIFICATIONS** Students can identify and explain the connections between their lives and technology and how technology affects their lives. **CONTENT FOCUS** The focus is on how technology has changed and the impact on students' lives. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. *Practice 2.* Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.

Strand	Impacts of Computing
Topic	**Culture**
	Practice 3. Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. *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	**Social Interactions**
IC.SI.K.a With guidance and support, identify and use safe and responsible behaviors concerning information and technology.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students use technology responsibly and safely with teacher support. In grade 1, with guidance, students will be able to describe how to be safe and responsible using technology. **IMPORTANT CONCEPTS** • Schools develop their own technology rules, regulations and etiquette **KEY SKILL/PROCEDURES** • With guidance and support, demonstrate use of technology available within the framework of the school's technology rules, regulations and etiquette **Content Elaborations** **CLARIFICATIONS** Etiquette topics might include cyberbullying, school policy and safe privacy practices. **CONTENT FOCUS** The focus is on the responsible use of technology in and out of the classroom. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. *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.K.a With guidance, discuss appropriate uses of technology to support informed decisions.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, with teacher support, students identify and explain basic security practices that should be applied when using the internet. With support, students identify personal information and explain why it is important to use security measures and to protect personal information. In grade 1, with guidance, students will continue to develop their understanding of private information, security practices when using the internet, and the importance of both. **IMPORTANT CONCEPTS** • Guidelines and practices to stay safe on the internet should be discussed and practiced. • Awareness of what private information is, what students should and should not share, and what are potential consequences of sharing private information **KEY SKILL/PROCEDURES** • With guidance and support, identify practices to stay safe on the internet **Content Elaborations** **CLARIFICATIONS** Provide students guidelines for safe navigation of the internet. Provide students opportunities to practice these guidelines by using teacher-selected internet sites. Provide students guidelines of what constitutes personal information and the consequences of misuse. Students have the opportunity to apply basic security practices as part of their activities addressing cybersecurity (NI.C.K.a)

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	CONTENT FOCUS The focus is to keep students safe when using the internet. **Computer Science Practices** *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. *Practice 2.* Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities. *Practice 7.* Communicating About Computing 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

GRADE 1

Strand	Computing Systems
Topic	**Devices**
CS.D.1.a Operate commonly used devices and their components to perform a variety of tasks.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students named and used common devices with guidance. In grade 1, students begin operating the devices independently. In grade 2, students will begin selecting devices with a purpose in mind. **IMPORTANT CONCEPTS** • Different devices operate in different ways **KEY SKILL/PROCEDURES** • Operate teacher-selected device for a specific task • Navigate digital learning tools **Content Elaborations** **CLARIFICATIONS** Students will recognize software/hardware and operate digital learning tools. **CONTENT FOCUS** The focus is on the student operating devices and software/hardware. **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	Computing Systems
Topic	Hardware/Software

CS.HS.1.a With guidance, describe and use hardware and software necessary for accomplishing a task.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, students named and used hardware and software with teacher support to perform functions. In grade 1, with guidance, students begin comparing hardware and software and their functions. In grade 2, students will use their knowledge of hardware and software to select what is needed to perform a task.

IMPORTANT CONCEPTS

- Hardware and software identification and the function they perform
- Hardware and software interact to work together

KEY SKILL/PROCEDURES

- With guidance, identify the differences between hardware and software, their functions and purpose
- With guidance, identify hardware and software interactions

Content Elaborations

CLARIFICATIONS

Students will compare and contrast hardware and software and their interactions.

CONTENT FOCUS

The focus is on the characteristics, functions and interactions of hardware and software.

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	Computing Systems
Topic	**Troubleshooting**
CS.T.1.a With guidance, use problem solving strategies to troubleshoot a problem.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students used a problem-solving process with teacher support to identify problems and begin troubleshooting. In grade 1, with guidance, and in grade 2, they will continue using a problem-solving process to troubleshoot. **IMPORTANT CONCEPTS** • There are a variety of problem solving processes. A problem-solving process typically includes identifying the problem, brainstorming solutions, making a plan, testing solutions, and revising **KEY SKILL/PROCEDURES** • With guidance, apply a problem-solving process, using appropriate terminology to solve a problem **Content Elaborations** **CLARIFICATIONS** Students will identify problems (e.g., left click or right click, no audio, no power, navigating windows) and attempt to solve them using a problem-solving process. **CONTENT FOCUS** The focus is on solving a problem using a problem-solving process. **COMPUTER SCIENCE PRACTICES** *Practice 6.* Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process. *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	Networks and the Internet
Topic	**Networking**
NI.N.1.a Create a list of ways information can be shared electronically to gain a deeper understanding of how information is transmitted (e.g., email, social media). **NI.N.1.b** Recognize that computing devices can be connected to retrieve information from the global community.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students were introduced to the idea of what a network is and how people use it. In grade 1, students begin to develop an understanding of concepts of networking and of unique identifiers within a global community. They also begin to develop an understanding of what devices people use to network and how each device people network with has a unique identifier. In addition, students recognize that the computing devices with unique identifiers can be connected together to access and retrieve information. In grade 2, students will describe what a network is, devices we use to network, how devices can be identified, and how they can be connected together. Additionally, students can network using devices to access and retrieve information within a global community. **IMPORTANT CONCEPTS** • Users of the internet communicate with a global community • All devices that are connected to the network have a unique identifier • A variety of information can be communicated electronically **KEY SKILL/PROCEDURES** • Interact with the global community • Create communications that could be transmitted electronically • Match devices with unique identifiers **Content Elaborations** **CLARIFICATIONS** Students will communicate and retrieve information. They will identify the devices we use to communicate. The internet is global. Each device has a unique identifier. This is not limited to IP addresses. A person's phone number can serve as a metaphor for a unique identifier. For example, two people can exchange information using their phones providing they call, or in other words connect to, the correct phone number.

Strand	Networks and the Internet
Topic	**Networking**
	CONTENT FOCUS The focus is on understanding networks, unique identifiers, and electronic communication. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. *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	Networks and the Internet
Topic	**Cybersecurity**
NI.C.1.a Identify and use secure practices (e.g., passwords) to protect private information.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten through grade 2, students work on being able to explain why it is important to use technology in a responsible way in order to make decisions about its use. Students also work to demonstrate how to use technology appropriately and safely and how to protect login information. **IMPORTANT CONCEPTS** • Decision making when using technology **KEY SKILL/PROCEDURES** • Create and use passwords appropriately • Log in and out of apps and devices **Content Elaborations** **CLARIFICATIONS** In grade 1, some students may still require assistance with their passwords. Focus on the importance of passwords staying in the classroom. This provides peer assistance with passwords, but allows the teacher to focus on the importance of not sharing passwords. **CONTENT FOCUS** The focus is on using passwords and devices appropriately. **COMPUTER SCIENCE PRACTICES** *Practice 7.* Communicating About Computing 3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

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

DA.DCS.1.a With guidance, collect and organize data to retrieve for later use. **DA.DCS.1.b** With guidance, demonstrate how data can be collected and stored in a variety of ways.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, students are collecting and sorting data in a variety of ways with teacher support. In grade 1, students begin storing and retrieving data with guidance. In grade 2, students will begin to retrieve data to modify. **IMPORTANT CONCEPTS** • Data is information. When using technology, data is often quantities, characters, or symbols that are the inputs and outputs of computer programs (see Code.org) • Data can be organized, collected, stored, and retrieved in a variety of ways **KEY SKILL/PROCEDURES** • Use appropriate tools to organize data • Use appropriate tools to collect data with guidance • With guidance, store, retrieve and save data **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. Students can create and, with guidance, retrieve files. Students can organize files (i.e., file structure). **CONTENT FOCUS** The focus is on storing and retrieving data. **COMPUTER SCIENCE PRACTICES** *Practice 4*. Developing and Using Abstractions 2. Evaluate existing technological functionalities and incorporate them into new designs.

Strand	Data and Analysis
Topic	**Visualization and Communication**
DA.VC.1.a Organize and present data in various formats to make observations.	## Expectations for Learning **LEARNING PROGRESSION** In kindergarten, students are presenting data in various formats. In grade 1, students will make observations of representations of data. In grade 2, they will continue to analyze data in various formats. **IMPORTANT CONCEPTS** • Data can be sorted by attributes • Data can be presented in a variety of formats **KEY SKILL/PROCEDURES** • Collect with guidance and organize data for peer understanding • Describe and sort data by different attributes to create multiple representation of the same data sets • Transfer data between grids to lists ## Content Elaborations **CLARIFICATIONS** Students can address this content with or without a computing device. Various formats can include: • graphic organizers • categorical sort • modeling • drawings • sorting by different attributes **CONTENT FOCUS** The focus to make observations on representations of data.

Strand	Data and Analysis
Topic	**Visualization and Communication**

	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, taking into account key features, time and resource constraints, and user experience. 2. Create a computational artifact for practical intent, personal expression, or to address a societal issue. 3. Modify an existing artifact to improve or customize it. *Practice 7.* Communicating About Computing 1. Select, organize, and interpret large data sets from multiple sources to support a claim. 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

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

DA.IM.1.a Create and explain a model of an object or process that includes patterns and key elements.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, students modeled data and identified patterns with guidance. In grade 1, students continue to model data and identify patterns and begin explaining their model. In grade 2, students will begin interpreting models.

IMPORTANT CONCEPTS

- Data can be represented through modeling
- Patterns within the data can be discovered and explained

KEY SKILL/PROCEDURES

- Model data to discover and identify patterns
- Explain the model and patterns discovered

Content Elaborations

CLARIFICATIONS

Students can address this content with or without a computing device.

Students model data through representation data visually, although not necessarily using paper and pencil as in graphs. Data can be modeled using manipulatives and physical models.

CONTENT FOCUS

The focus is on modeling data, pattern detection, and explanation of the model.

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, taking into account key features, time and resource constraints, and user experience.
2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.
3. Modify an existing artifact to improve or customize it.

Strand	Data and Analysis
Topic	**Inference and Modeling**
	Practice 6. Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. *Practice 7.* Communicating About Computing 1. Select, organize, and interpret large data sets from multiple sources to support a claim. 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**

ATP.A.1.a With guidance, model a real-world process by constructing and following step-by-step directions (i.e., algorithms) to complete tasks.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, students constructed and followed instructions verbally and/or pictorially with teacher support. In grade 1, students construct and follow directions with guidance to complete a task in a real-world context through pictures and written words. In Grade 2, students will construct and follow instructions to complete a task through pictorial symbols and written words.

IMPORTANT CONCEPTS

- Step by step directions can be constructed to complete a real-world task
- Directions can be given verbally or visually

KEY SKILL/PROCEDURES

- With guidance, complete a verbal and/or visual task with multiple steps

Content Elaborations

CLARIFICATIONS

Students will follow multiple-step directions with precision to complete a task. Students should be able to use a task from their daily lives (e.g., brush teeth, washing hands, getting ready for school) and create the multiple steps necessary to complete that task. Students should articulate the steps to a task using visual representations, such as simple flow charts or diagrams, and written expression. Algorithms are commonly implemented using a precise language that computers can interpret.

CONTENT FOCUS

The focus is on multi-step directions and the sequence of steps to complete a task.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Practice 6. Testing and Refining Computational Artifacts
2. Identify and fix errors using a systematic process.

Strand	**Algorithmic Thinking and Programming**
Topic	**Algorithms**
	Practice 7. Communicating About Computing 1. Select, organize, and interpret large data sets from multiple sources to support a claim. 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

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

ATP.VDR.1.a Categorize a group of items (e.g., numbers, symbols or pictures) based on the attributes or actions of each item, with or without a computing device.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, students recognized that numbers, symbols and pictures represent information. In grade 1, students use numbers, symbols and pictures to represent information. In grade 2, students will model the use of numbers, symbols and pictures to manipulate and store information.

IMPORTANT CONCEPTS

- Numbers, symbols or pictures can be categorized by attributes or actions

KEY SKILL/PROCEDURES

- Categorize numbers, symbols and/or pictures based on multiple attributes or actions

Content Elaborations

CLARIFICATIONS

Information in the real world can be represented in computer programs. (K-12 Computer Science Framework, 2016)

Students will manipulate numbers, symbols and pictures to categorize information.

CONTENT FOCUS

The focus is on categorizing data based on attributes and/or actions.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

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	Algorithmic Thinking and Programming
Topic	**Control Structures**
ATP.CS.1.a With guidance, model a sequence of instructions (i.e., program) that includes repetition (i.e., loops) to solve a problem or express ideas.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten, with teacher support, students modeled simple sequences and ordered steps of an algorithm to solve a problem and express ideas. In grade 1, with guidance, students include loops in their sequence to express an idea or solve a problem. Students utilize loops in a sequence to demonstrate repetition in their sequence and to simplify the steps to create or model their algorithm. In grade 2, students will create a program that utilizes sequencing and loops. **IMPORTANT CONCEPTS** • An algorithm is a sequence of steps • Programs may be modeled to express an idea or solve a problem • A loop is a repeated sequence of steps **KEY SKILL/PROCEDURES** • Identify a sequence as an algorithm • With guidance, identify a repeated sequence as a loop • With guidance, model algorithms and loops to follow a process **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. Loops are repeated sequences. Modeling a program means the students are provided the program to follow; they are not creating it. Modeling can be done visually or verbally. **CONTENT FOCUS** The focus is on sequencing, process (i.e., steps), loops and problem solving.

Strand	Algorithmic Thinking and Programming
Topic	**Control Structures**
	COMPUTER SCIENCE PRACTICES *Practice 4.* Developing and Using Abstractions 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *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	Algorithmic Thinking and Programming
Topic	**Modularity**
ATP.M.1.a With guidance, break down (i.e., decompose) a series of steps and separate the necessary from the unnecessary steps to create a precise sequence of instructions to solve a problem or express an idea.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 1, with guidance, students determine what information is necessary to complete a sequence or process. In grade 2, students will determine what information is necessary to complete a more complex sequence or process. **IMPORTANT CONCEPTS** • Decomposition is to break down a series of steps • Abstraction is to determine the information that is relevant to solve a problem **KEY SKILL/PROCEDURES** • With guidance, decompose a problem into a series of steps • With guidance, abstract information relevant to the problem being solved **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. Students will start with a simple sequence of at least three steps (e.g., beginning, middle and end) and move to a more complex sequence of more than three steps. Abstraction is to determine which information is relevant or irrelevant to the problem. Decomposition is taking a problem and breaking it into steps. **CONTENT FOCUS** The focus is on decomposing and the abstraction of information in a sequence of instructions to solve a problem. **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.

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

ATP.PD.1.a With guidance, plan and create an artifact to illustrate thoughts, ideas and problems in a sequential (step-by-step) manner (e.g., story map, storyboard, sequential graphic organizer).

ATP.PD.1.b With guidance, identify and fix (i.e., debug) a multi-step process that includes sequencing.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, with teacher support, students planned and/or created an artifact to illustrate thoughts, ideas, and problems in a sequential manner. In grade 1, with guidance, students continue to plan and create, as well as begin to debug an artifact in order to illustrate thoughts, ideas, and problems in a sequential manner. In grade 2, students will continue to plan, create and/or debug an artifact to illustrate thoughts, ideas, and problems in a sequential manner.

IMPORTANT CONCEPTS

- Artifacts illustrate thoughts, ideas and problems in a sequential manner
- When creating artifacts, it is important to review your artifact for errors

KEY SKILL/PROCEDURES

- With guidance, plan and create an artifact to illustrate thoughts, ideas and problems in a sequential manner
- With guidance, evaluate an artifact for errors

Content Elaborations

CLARIFICATIONS

An artifact is anything created by a human. An artifact could be a visual program, story map, story board or sequential graphic organizer.

Debug is defined as "to identify and fix."

CONTENT FOCUS

The focus is on creating and debugging artifacts and programs.

COMPUTER SCIENCE PRACTICES

Practice 5. Creating a Computational Artifact

1. Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, taking into account key features, time, and resource constraints, and user expectations.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	2. Create a computational artifact for practical intent, personal expression, or to address a societal issue. *Practice 6.* Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process. *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	Culture

IC.Cu.1.a Discuss different technologies and their impact on everyday life.

IC.Cu.1.b Identify how people use and are impacted by many types of technologies in their daily work and personal lives.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, students identified what technology is and how it has changed and impacted their lives. In grade 1, they recognize the different ways technology impacts and the role technology plays in their lives. In grade 2, students will compare and contrast how technology use has changed and the impact it has on their lives positively and negatively.

IMPORTANT CONCEPTS

- Technology plays a role in our everyday life
- Technology is constantly changing and affects how we live

KEY SKILL/PROCEDURES

- Compare past and present technology and how it affects our lives

Content Elaborations

CLARIFICATIONS

Students can identify and explain the connections between their lives and technology and how technology affects their lives.

CONTENT FOCUS

The focus is on how technology has changed and the impact on students' lives.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.
2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability.

Practice 2. Collaborating Around Computing

1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.

Strand	Impacts of Computing
Topic	**Culture**
	Practice 3. Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally *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	**Social Interactions**

IC.SI.1.a With guidance, describe safe and responsible behaviors for the use of information and technology.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, students used technology responsibly and safely with teacher support. In grade 1, with guidance, students are able to describe how to be safe and responsible using technology. In grade 2, students will be able to compare and contrast safe and responsible technology behaviors.

IMPORTANT CONCEPTS

- Schools develop their own technology rules, regulations and etiquette

KEY SKILL/PROCEDURES

- With guidance, describe appropriate behaviors on how to use technology and apply those rules, regulations and etiquette within the classroom

Content Elaborations

CLARIFICATIONS

Etiquette topics might include cyberbullying, school policy and safe privacy practices.

CONTENT FOCUS

The focus is on the responsible use of technology in and out of the classroom.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.
2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability.

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.1.a With guidance, discuss appropriate and ethical uses of technology to guide informed decisions.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, students used technology responsibly and safely with teacher support. In grade 1, with guidance, students are able to describe how to be safe and responsible using technology. In grade 2, students will be able to compare and contrast safe and responsible technology behaviors.

IMPORTANT CONCEPTS

- Guidelines and practices to stay safe on the internet should be discussed and practice
- Awareness of what private information is, what you should and should not share, and what are potential consequences of sharing private information

KEY SKILL/PROCEDURES

- With guidance, identify practices to stay safe on the internet and provide examples of situations where these practices should be applied

Content Elaborations

CLARIFICATIONS

Provide students guidelines for safe navigation of the internet. Provide students opportunities to practice these guidelines by using teacher-selected internet sites.

Provide students guidelines of what constitutes personal information and the consequences of misuse.

Students have the opportunity to apply basic security practices as part of their activities addressing cybersecurity (NI.C.1.a)

CONTENT FOCUS

The focus is to keep students safe when using the internet.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	COMPUTER SCIENCE PRACTICES *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. *Practice 2.* Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities. *Practice 7.* Communicating About Computing 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

GRADE 2

Strand	Computing Systems
Topic	**Devices**
CS.D.2.a Select and operate commonly used devices to perform a variety of tasks.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 1, students began operating devices independently. In grade 2, students begin selecting devices with a purpose in mind. In grade 3, students will develop an understanding that the device they selected for a specific task has components that all play a role in the computer system. The data is entered into an external device and is then placed into the computer system where it can be shared locally and globally. **IMPORTANT CONCEPTS** • Different devices can be used to perform specific tasks. **KEY SKILL/PROCEDURES** • Choose between devices that can perform specific tasks **Content Elaborations** **CLARIFICATIONS** Students will use their knowledge of hardware and software from kindergarten and grade 1 to make a selection to complete a task. **CONTENT FOCUS** The focus is on the student making a selection (i.e., device, software, hardware) to complete a task. **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. *Practice 2*. Collaborating Around Computing 4. Evaluate and select technological tools that can be used to collaborate on a project. *Practice 6.* Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process.

Strand	Computing Systems
Topic	**Devices**
	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	Computing Systems
Topic	**Hardware and Software**
CS.HS.2.a Select and use hardware and software necessary for accomplishing a task.	## Expectations for Learning **LEARNING PROGRESSION** In grade 1, students began comparing hardware and software and their functions with guidance. In grade 2, students begin selecting devices with a purpose in mind. In grade 3, students will select learning tools or devices in order to plan, implement, and reflect upon tasks. **IMPORTANT CONCEPTS** • Hardware and software selection to perform a specific task • Hardware and software interact to work together **KEY SKILL/PROCEDURES** • Identify hardware and software interactions • Select hardware and/or software to perform a specific task ## Content Elaborations **CLARIFICATIONS** Students will select hardware and software with a specific purpose in mind. **CONTENT FOCUS** The focus is on the selection of a tool to complete a specific task. **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. *Practice 2.* Collaborating Around Computing 4. Evaluate and select technological tools that can be used to collaborate on a project. *Practice 6.* Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process.

Strand	Computing Systems
Topic	**Hardware and Software**
	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	Computing Systems
Topic	**Troubleshooting**

CS.T.2.a Use problem solving strategies to troubleshoot a problem.

Expectations for Learning

LEARNING PROGRESSION

In grade1, with guidance, and in grade 2, students continue using a problem-solving process to troubleshoot. In grade 3, students will begin to move beyond trial and error to apply more strategic troubleshooting techniques to fix their problems.

IMPORTANT CONCEPTS

- There are a variety of problem solving processes. A problem-solving process typically includes identifying the problem, brainstorming solutions, making a plan, testing solutions, and revising

KEY SKILL/PROCEDURES

- Apply a problem-solving process, using appropriate terminology to solve a problem

Content Elaborations

CLARIFICATIONS

Students will identify problems (e.g., left click or right click, no audio, no power, navigating windows) and attempt to solve them using a problem-solving process.

CONTENT FOCUS

The focus is on solving a problem using a problem-solving process.

COMPUTER SCIENCE PRACTICES

Practice 6. Testing and Refining Computational Artifacts

1. Systematically test computational artifacts by considering all scenarios and using test cases.
2. Identify and fix errors using a systematic process.

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	Networks and the Internet
Topic	**Networking**
NI.N.2.a Describe how information can be communicated electronically to gain a deeper understanding of how information is transmitted (e.g., email, social media). **NI.N.2.b** Use computing devices that are connected to share and receive information from the global community.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 1, students began to develop an understanding of concepts of networking and of unique identifiers within a global community. Students also began to develop an understanding of what devices people use to network and how each device people network with has a unique identifier. In addition, students recognized that the computing devices with unique identifiers can be connected together to access and retrieve information. In grade 2, students can describe what a network is, devices we use to network, how devices can be identified, and how they can be connected together. Additionally, students can network using devices to access and retrieve information within a global community. In grade 3, students will explore how information is sent and received over the internet. Students will continue to build an understanding of how information is sharing, received, and stored. **IMPORTANT CONCEPTS** • Users of the internet communicate with a global community • All devices that are connected to the network have a unique identifier • A variety of information can be communicated electronically **KEY SKILL/PROCEDURES** • Interact with the global community • Create and use communications that are transmitted electronically • Match devices with unique identifiers **Content Elaborations** **CLARIFICATIONS** Students will communicate and retrieve information. They will identify the devices we use to communicate. The internet is global. Each device has a unique identifier. This is not limited to IP addresses. A person's phone number can serve as a metaphor for a unique identifier. For example, two people can exchange information using their phones providing they call, or in other words connect to, the correct phone number.

Strand	Networks and the Internet
Topic	**Networking**
	CONTENT FOCUS The focus is on understanding and using networks, unique identifiers, and electronic communication. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. *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	Networks and the Internet
Topic	**Cybersecurity**
NI.C.2.a Explain and demonstrate secure practices (e.g., creating strong passwords) to protect private information.	**Expectations for Learning** **LEARNING PROGRESSION** In kindergarten through grade 2, students work to explain why it is important to use technology in a responsible way in order to make decisions about its use. Students also work to demonstrate how to use technology appropriately and safely and how to protect login information. In grade 3, students will identify personal information and how passwords are used to protect that information. **IMPORTANT CONCEPTS** • Decision making when using technology **KEY SKILL/PROCEDURES** • Create and use passwords appropriately • Log in and out of apps and devices • Explain and demonstrate secure practices **Content Elaborations** **CLARIFICATIONS** Students need to be able to apply the skills below to demonstrate understanding of the content statement: • Protecting their password • Making strong passwords • Logging in and out of apps and devices • Being responsible • Discussing impacts of poorly secured information **CONTENT FOCUS** The focus is on using passwords and devices appropriately and explaining the importance of secure practices.

Strand	Networks and the Internet
Topic	**Cybersecurity**
	COMPUTER SCIENCE PRACTICES *Practice 7.* Communicating About Computing 3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

Strand	Data and Analysis
Topic	**Data Collection and Storage**
DA.DCS.2.a Collect and organize data to store, retrieve and modify. **DA.DCS.2.b** Manipulate data to perform various tasks.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 1, students began storing and retrieving data with guidance. In grade 2, students begin to retrieve data to modify. In grade 3, students will use different software tools to access data and store it in different locations. In grade 3, students will collect, record and maintain data, over time, using various tools, such as a thermometer, ruler, scale, and surveys. **IMPORTANT CONCEPTS** • Data is information. When using technology, data is often quantities, characters, or symbols that are the inputs and outputs of computer programs (see Code.org) • Data can be organized, collected, stored, and retrieved in a variety of ways **KEY SKILL/PROCEDURES** • Use appropriate tools to organize data • Use appropriate tools to collect data • Store, retrieve and save data • Edit, revise, and rename data **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. A structured set of data can be used to help students learn the skills of retrieving and organizing data. **CONTENT FOCUS** The focus is on modifying retrieved data. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 2. Evaluate existing technological functionalities and incorporate them into new designs.

Strand	Data and Analysis
Topic	**Visualization and Communication**
DA.VC.2.a Organize, analyze and present data in various formats.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 1 students will make observations of representations of data. In grade 2, they will continue to analyze data in various formats. In grade 3, students will extend their knowledge by creating scaled picture and bar graphs. They will also create line plots using scales that include whole numbers and fractions (e.g., halves and fourths). **IMPORTANT CONCEPTS** • Data can be sorted by attributes • Data can be presented in a variety of formats **KEY SKILL/PROCEDURES** • Collect, organize and analyze data for peer understanding • Describe and sort data by different attributes to create multiple representation of the same data sets • Transfer data between grids to lists **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. Various formats can include: • concept maps • Venn diagrams • categorical sort • modeling • drawings • sorting by different attributes Students can analyze data by looking at the data of two mammals, for example. What traits do they have in common? What traits are different?

Strand	Data and Analysis
Topic	**Visualization and Communication**
	CONTENT FOCUS The focus is on the analysis of representations of data. **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, taking into account key features, time and resource constraints, and user experience. 2. Create a computational artifact for practical intent, personal expression, or to address a societal issue. 3. Modify an existing artifact to improve or customize it. *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. *Practice 7.* Communicating About Computing 1. Select, organize, and interpret large data sets from multiple sources to support a claim. 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

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

DA.IM.2.a Interpret and analyze data, graphs, models or charts.

Expectations for Learning

LEARNING PROGRESSION

In grade 1, students continued to model data and identify patterns and began explaining their model. In grade 2, students begin interpreting models. In grade 3, students will analyze and explain relationships or patterns and predict an unknown.

IMPORTANT CONCEPTS

- Data can be represented through modeling
- Patterns within the data can be discovered, explained, and interpreted.

KEY SKILL/PROCEDURES

- Model data to discover and identify patterns
- Explain the model and patterns discovered
- Interpret the meaning of the patterns discovered

Content Elaborations

CLARIFICATIONS

Students can address this content with or without a computing device.

Students model data through representation data visually, although not necessarily using paper and pencil as in graphs. Data can be modeled using manipulatives and physical models.

CONTENT FOCUS

The focus is on the interpretation and analysis of the model.

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, taking into account key features, time and resource constraints, and user experience.
2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.
3. Modify an existing artifact to improve or customize it.

Strand	Data and Analysis
Topic	**Inference and Modeling**
	Practice 6. Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. *Practice 7*. Communicating About Computing 1. Select, organize, and interpret large data sets from multiple sources to support a claim. 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**
ATP.A.2.a Model a real-world process by constructing and following step-by-step instructions (i.e., algorithms) to complete tasks.	**Expectations for Learning** In grade 1, students constructed and followed directions through pictures and written words with guidance. In grade 2, students construct and follow directions in a real-world context through written words, statements, and visual symbols. In grade 3, students will create step-by-step tasks (i.e., algorithms) and find errors within an algorithm. **IMPORTANT CONCEPTS** • Step by step directions can be constructed to complete a real-world task • Directions can be given verbally or visually **KEY SKILL/PROCEDURES** • Construct and complete a verbal and/or visual task with multiple steps **Content Elaborations** **CLARIFICATIONS** Students identify a task from their daily life (e.g., brush teeth, getting ready for school, walking home from school) and break it into a sequence of steps (i.e., algorithm). Students should construct a sequence of steps to complete a task using precise language and visuals/symbols, in order to see the effects of a sequence. Students should compare sequences for the same task, to identify similarities and differences within the sequence. Algorithms are commonly implemented using a precise language that computers can interpret. **CONTENT FOCUS** The focus is on construction of multi-step directions and the sequence of steps to complete a task. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *Practice 6.* Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process.

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

ATP.VDR.2.a Construct a model that shows the way programs store and manipulate data by using numbers or other symbols to represent information.

Expectations for Learning

LEARNING PROGRESSION

In grade 1, students used numbers, symbols and pictures to represent information. In grade 2, students model the use of numbers, symbols and pictures to manipulate and store information. In grade 3, students will define and identify variables to understand how they are used in algorithms.

IMPORTANT CONCEPTS

- Numbers, symbols, or pictures can be used to model programming
- Information is stored in a variety of ways

KEY SKILL/PROCEDURES

- Model programming using symbols, numbers, or pictures
- Store information in a variety of ways

Content Elaborations

CLARIFICATIONS

Information in the real world can be represented in computer programs. (K-12 Computer Science Framework, 2016)

Computers use stored information by choosing only relevant information.

CONTENT FOCUS

The focus is on modeling the way programs store and manipulate data.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Practice 6. Testing and Refining Computational Artifacts
2. Identify and fix errors using a systematic process.

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

ATP.CS.2.a Develop a program that uses sequencing and repetition (i.e., loops) to solve a problem or express ideas.

Expectations for Learning

LEARNING PROGRESSION

In grade 1, with guidance, students modeled loops in their sequence of steps or program to show repetition. In grade 2, students create a program that utilizes sequencing and loops. In grade 3, students will 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.

IMPORTANT CONCEPTS

- Programs are made of algorithms and loops

KEY SKILL/PROCEDURES

- Create a program utilizing algorithms and loops

Content Elaborations

CLARIFICATIONS

Students can address this content with or without a computing device.

Students create, or in other words, construct a program.

Loops are repeated sequences.

CONTENT FOCUS

The focus is on using sequencing, process, loops, and problem solving to create an algorithm (i.e., program).

COMPUTER SCIENCE PRACTICES

Practice 5. Creating a Computational Artifact

1. Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, taking into account 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	**Control Structures**
	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	Algorithmic Thinking and Programming
Topic	**Modularity**
ATP.M.2.a Break down (i.e., decompose) a series of steps and separate the necessary from the unnecessary steps to create a precise sequence of instructions to solve a problem or express an idea.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 1, with guidance, students determined what information is necessary to complete a sequence or process. In grade 2, students determine what information is necessary to complete a more complex sequence or process. In grade 3, students will decompose abstractions into sequences to design algorithms. **IMPORTANT CONCEPTS** • Decomposition is to break down a series of steps • Abstraction is to use the relevant information **KEY SKILL/PROCEDURES** • Decompose a problem into a series of steps • Abstract information relevant to the problem being solved **Content Elaborations** **CLARIFICATIONS** Students can address this content with or without a computing device. Students will work with a more complex sequence of more than three steps. Abstraction is to determine which information is relevant or irrelevant to the problem. Decomposition is taking a problem and breaking it into steps. **CONTENT FOCUS** The focus is on decomposing and the abstraction of information in a sequence of instructions to solve a problem. **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.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
ATP.PD.2.a Plan and create an artifact to illustrate thoughts, ideas and problems in a sequential (step-by-step) manner (e.g., story map, storyboard, sequential graphic organizer). **ATP.PD.2.b** Identify and fix (i.e., debug) a multi-step process that includes sequencing.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 1, with guidance, students continued to plan and create, as well as began to debug an artifact in order to illustrate thoughts, ideas, and problems in a sequential manner. In grade 2, students continue to plan, create or fix an artifact to illustrate thoughts, ideas, and problems in a sequential manner. In grade 3, students will use these skills to design and create programs to solve a problem. In grade 3, guided questions will be asked to help students think more strategically about how to solve a problem in their program **IMPORTANT CONCEPTS** • Artifacts illustrate thoughts, ideas and problems in a sequential manner • When creating artifacts, it is important to review your artifact for errors **KEY SKILL/PROCEDURES** • Plan and create an artifact to illustrate thoughts, ideas and problems in a sequential manner • Evaluate an artifact for errors **Content Elaborations** **CLARIFICATIONS** An artifact is anything created by a human. An artifact could be a visual program, story map, story board or sequential graphic organizer. Debug is defined as "to identify and fix." **CONTENT FOCUS** The focus is on creating and debugging artifacts and programs. **COMPUTER SCIENCE PRACTICES** *Practice 5*. Creating a Computational Artifact 1. Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, taking into account key features, time, and resource constraints, and user expectations.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	2. Create a computational artifact for practical intent, personal expression, or to address a societal issue. *Practice 6.* Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process. *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	**Culture**

IC.Cu.2.a Compare and contrast how the use of technology has changed to understand its impact on everyday life.

IC.Cu.2.b Describe the ways people use technologies in their daily work and personal lives to understand technology's impact on one's community.

Expectations for Learning

LEARNING PROGRESSION

In grade 1, students recognized the different ways technology impacts and the role technology plays in their lives. In grade 2, students compare and contrast how technology use has changed and the impact it has on their lives positively and negatively. In grade 3, students will identify the impact technology has on everyday life in the local community. Students will identify diverse user needs and how computing devices have features built in to increase accessibility to all users.

IMPORTANT CONCEPTS

- Technology is always changing. These changes affect our communities and the role it plays in our lives

KEY SKILL/PROCEDURES

- Describe the changes in technology and how we interact with technology over time
- Demonstrate how humans adapt technology to serve their needs
- Demonstrate how technology can have negative consequences

Content Elaborations

CLARIFICATIONS

Students can identify and explain the connections between their lives and technology and how technology affects their lives.

CONTENT FOCUS

The focus is on how technology has changed and the impact on students' lives.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.
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	**Culture**
	Practice 2. Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities. *Practice 3.* Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. *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	**Social Interactions**
IC.SI.2.a Compare and contrast safe and responsible behaviors to those that are not when using information and technology.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 1, with guidance, students were able to explain safe and responsible behaviors associated with using information and technology while working with others online. In grade 2, students are able to compare and contrast safe and responsible technology behaviors. In grade 3, students will apply a code of conduct to safely and responsibly use technology within an online community. In grade 3, students will collaborate through feedback and reflection to improve a digital artifact and begin to explore how diverse perspectives improves a digital product. **IMPORTANT CONCEPTS** • Schools develop their own technology rules, regulations and etiquette **KEY SKILL/PROCEDURES** • Create rules based on the school technology rules, regulations and etiquette on how to use technology • Apply created rules within the classroom and during students' own use of technology • Identify inappropriate actions and the consequences **Content Elaborations** **CLARIFICATIONS** Etiquette topics might include cyberbullying, school policy, and safe privacy practices. **CONTENT FOCUS** The focus is on the responsible use of technology in and out of the classroom. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 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**
	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.2.a Discuss appropriate and ethical uses of technology to guide informed decisions.

Expectations for Learning

LEARNING PROGRESSION

In grade 1, with guidance, students continued to identify and explain basic security practices that should be applied when using the internet. In grade 2, in concert with cybersecurity activities, students are able to recognize weak security practices, implement secure practices to protect private information to ensure security is not compromised and to explain why it is important to apply these measures. In grade 3, the focus will continue to focus on security, while also giving students more explanation regarding why it is important to keep information secure. Information security and the concept of a digital footprint will be introduced for the first time in grade 3.

IMPORTANT CONCEPTS

- Guidelines and practices to stay safe on the internet should be discussed and practiced
- Awareness of what private information is, what you should and should not share, and what are potential consequences of sharing private information

KEY SKILL/PROCEDURES

- Identify practices to stay safe on the internet; Provide examples of situations where these practices should be applied and describe different consequences that may result from not using safe practices

Content Elaborations

CLARIFICATIONS

Provide students guidelines for safe navigation of the internet. Provide students opportunities to practice these guidelines by using teacher-selected internet sites.

Provide students guidelines of what constitutes personal information and the consequences of misuse. Provide them guidelines on how to create strong passwords.

Students have the opportunity to apply security practices as part of their activities addressing cybersecurity (NI.C.2.a)

CONTENT FOCUS

The focus is to keep students safe when using the internet.

Strand	**Impacts of Computing**
Topic	**Safety, Law and Ethics**
	COMPUTER SCIENCE PRACTICES *Practice 1*. Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. *Practice 2.* Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities. *Practice 7*. Communicating About Computing 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

GRADES 3-5

GRADE 3

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 upon 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 keyboard.

COMPUTER SCIENCE PRACTICES

Strand	**Computing Systems**
Topic	**Devices**
	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 in order 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, implementing, and reflecting 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, devices we use to network, how devices can be identified, and how they can be connected together. 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 or not 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, devices we use to network, how devices can be identified, and how they can be connected together. 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 similar to his or her personal 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	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 a period of 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.

Strand	Data and Analysis
Topic	**Data Collection and Storage**
	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 picture 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 appropriate scale for 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 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, end to create organized steps should be emphasized in order 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 in order to avoid typing a command several times
- Insert a conditional in a program in order 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.

Strand	Algorithmic Thinking and Programming
Topic	**Control Structures**
	Events can be thought of as an action as a result of an action such as, "When I click the mouse, the image rotates." 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** The focus is 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 own 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 in order to modify the result of the algorithm
- Recognize pseudocode and flow charts

Content Elaborations

CLARIFICATIONS

Processes of logical thought should include dissection of a whole to 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.

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.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**
	Practice 4. Developing and Using Abstractions 3. Create modules and develop points of interaction that can apply to multiple situation 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 create simple programs in a sequential manner 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 1 or 2 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, taking into account 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 problem 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., 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 errors in block-based environment program and through guided questioning determining solutions and apply the fix.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	COMPUTER SCIENCE PRACTICES *Practice 6.* Testing and Refining Computational Artifacts 2. Identify and fix errors using a systematic process.

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 own perspectives when designing and developing computational products.

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 Cultures

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 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 through modeling this process. Teachers should conduct whole group discussions after students have left feedback to determine if 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 expectation and equitable workloads to increase efficiency and effectives.
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 needs to be cited properly.

Strand	Impacts of Computing
Topic	Safety, Law and Ethics
	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 number, 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 is introduced for the first time. In grade 4, students will spend time considering their own 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.

GRADE 4

Strand	Computing Systems
Topic	**Devices**
CS.D.4.a Explore external 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 3, students developed an understanding that the device they selected for a specific task has components that all play a role in the computer system. In grade 4, students develop their understanding of what external components are used to share information. In grade 5, students will develop their understanding of the internal parts of the computer and how they play a role in the computer system. **IMPORTANT CONCEPTS** • External devices are used to input, store and transfer 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 external components (i.e., parts) such as USB port, HDMI, network cable, power supply, etc. • Select appropriate device to accomplish a task • Describe the components of the selected device **Content Elaborations** **CLARIFICATIONS** External components (i.e., parts) in this grade level may focus upon things plugged-in or attached to the computer. External components can include a USB port and drive, power supply, network cable, or HDMI port. Depending on the device, some of these components may or may not exist. For example, on some tablets a USB port is not available. Mobile devices do not always require the device to be plugged in to the power source. **CONTENT FOCUS** The focus should be upon students understanding the components (i.e., parts) of the device that they select for their task. For example, if they select a networked computer, this can allow them to

Strand	**Computing Systems**
Topic	**Devices**
	communicate with others globally. If their computer is not connected to a network, their communication is limited. **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.4.a Select and use digital learning tools/devices to support planning, implementing and reflecting upon a defined task.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students selected learning tools or devices in order to plan, implement, and reflect upon tasks. In grade 4, students continue to select learning tools/devices and use them to aid in planning, implementing, and reflecting on given tasks. In grade 5, students will use and evaluate the digital learning tools and devices they've chosen and consider the planning, implementation, and reflection across curricular areas.

IMPORTANT CONCEPTS

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

KEY SKILL/PROCEDURES

- Select and use a tool such as a presentation software program, document, graphic design program, video creating 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 should begin to extend to apps and programs beyond basic programs provided on selected device. Selection and use of a variety of devices such as tablets, desktops, laptops should be included.

CONTENT FOCUS

The focus is on students selecting and using their own tools or devices. Tasks should increase in complexity from third grade and focus on specific curricular goals in subject content.

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.4.a Diagnose problems and select an appropriate solution from a list of problems and solutions to resolve hardware and software issues.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 3, students began to move beyond trial and error to apply more strategic troubleshooting techniques to fix their problems. In grade 4, students focus on diagnosing and describing potential hardware and software problems. In grade 5, students will work to diagnose problems, describe the problem, and develop strategies to resolve technology issues. **IMPORTANT CONCEPTS** • Troubleshooting strategies can be used to solve hardware and software issues **KEY SKILL/PROCEDURES** • Diagnose problems in hardware and software • Select a solution for the problem from a given list **Content Elaborations** **CLARIFICATIONS** Students should describe the reason for the problem. For example, if the computer does not turn on, maybe the battery is dead. If the program does not work, maybe the username or password is wrong. If needed, students should be able to select solutions from a list of potential solutions. Students should be exposed to specific problems so they can develop the skills to troubleshoot in the future (i.e., disconnecting a computer from the network so that students are able to see what this looks like). **CONTENT FOCUS** The focus is on students diagnosing and describing problems. Students should be able to select solutions. **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.4.a Describe how information is broken down to be transmitted over a network to help students gain a better understanding of the internet and networks.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 3, students explored how information is sent and received over the internet. In grade 4, students explain how information is broken apart, sent and received over the internet. In grade 5, students will demonstrate how information is broken apart, sent and received over the internet. **IMPORTANT CONCEPTS** • Manipulating a URL (i.e., web address) even slightly can change what information is accessed • Information is broken into parts at the sending point and reassembled at the receiving point **KEY SKILL/PROCEDURES** • Modify a URL (i.e., web address) to access content • Describe what occurs when a URL is modified • Use a metaphorical example to describe how information is broken down into parts and reassembled **Content Elaborations** **CLARIFICATIONS** Students should understand that altering a URL will change the information that is displayed. An example of a metaphorical connection students could make to describe how information is transmitted would be a roller coaster ride. The track could be seen as the internet connection and the cars and the people are the information traveling through the connection. **CONTENT FOCUS** The focus is on students modifying a URL to reach a specific site and describing how the modification impacts the information accessed. Students communicate how information is transmitted. **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 Inernet
Topic	**Networking**

NI.N.4.b Describe network addresses, names and rules (i.e., protocols) to share or receive information from the global community.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students have developed an understanding of how information is shared, received and stored. In grade 4, students identify that different naming techniques are related to the type of information accessed. In grade 5, students will continue applying this knowledge.

IMPORTANT CONCEPTS

- Different types of rules for naming a web address identify different types of sites
- The search terms or web address is converted to a format that the computer can read to reach the desired site

KEY SKILL/PROCEDURES

- Identify the reliability of a site based on the naming rule (e.g., top level domain)
- Use search techniques (Boolean) to allow the computer to understand what is being searched

Content Elaborations

CLARIFICATIONS

Students identify reliability based on the top-level domain naming such as ".edu" for education purposes, ".com" for commercial purposes, ".gov" for government purposes, and ".org" for organizations.

Boolean searches use " ", *and, or*, etc.

CONTENT FOCUS

The focus is on identifying informational reliability and making a connection between search terms and website 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 Inernet
Topic	**Cybersecurity**

NI.C.4.a Describe what information should be protected and the importance of a secure password to protect information.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students explored and understood personal information and how passwords are used to protect information. In grade 4, students describe types of private information and the importance of protecting that information. In grade 5, students will create secure passwords to protect personal information and store them securely.

IMPORTANT CONCEPTS

- Personal information should be protected by secure passwords
- Potential consequences of personal information being unsecure

KEY SKILL/PROCEDURES

- Describe why personal information needs to be protected
- Describe what could happen if personal information is unsecure

Content Elaborations

CLARIFICATIONS

Students often only associate the worst-case scenario of sharing information. They need to understand real-world dangers of personal information being shared in an unsecure environment.
Students need to know what a secure password looks like and why they should use a secure password.

CONTENT FOCUS

The focus is on students identifying why information needs to be protected and being aware of consequences related to unsecure information.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems

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

Strand	Data and Analysis
Topic	**Data Collection and Storage**
DA.DCS.4.a Gather and organize multiple quantitative data elements using a tool to perform various tasks.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 3, students collected, recorded and maintained data over time using various tools, such as a thermometer, ruler, scale and survey. In grade 4, students build upon the use of tools from grade 3, to collect data from multiple sources within a singular topic over time. In grade 5, students will select appropriate tools to collect data from multiple sources within a singular topic over time. **IMPORTANT CONCEPTS** • Keeping an organized record of data over time is critical to analyzing data • Various tools can be used to generate 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 from multiple sources within a singular topic over a period of time • Collect data from multiple sources within a singular topic, by making repeated observations over time **Content Elaborations** **CLARIFICATIONS** Tools that may be explored are digital thermometers, GPS sensors, calculators, scales, digital forms (i.e., survey tools), length measurement tools, a stopwatch, etc. Data can be organized by using various digital and non-digital tables and charts. Digital organizational resources could include spreadsheets, online graphing programs, etc. An example of collecting data from multiple sources within a singular topic could be collecting the height of students in three different classes throughout the school year. **CONTENT FOCUS** The focus is on students collecting, recording, maintaining and organizing data from multiple sources within a singular topic over time.

Strand	Data and Analysis	
Topic	**Data Collection and Storage**	
		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.4.b Identify techniques and formats to store, process and retrieve different types of information.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 3, students used different software tools to access data and store it in different locations. In grade 4, students begin to gain an understanding that different file types may require different storage. In grade 5, students will use their knowledge of file types to explore how file size impacts storage. **IMPORTANT CONCEPTS** • Different data is stored in different ways on a computing device • Data can be stored locally, on a computing device or online • How data is stored impacts accessibility **KEY SKILL/PROCEDURES** • Store data as a specific file type • 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, or documents. Examples of file types would be image (i.e., .jpg, .png, .gif .bmp), document (e.g., .doc, .docx, .pages, .txt), multi-media (e.g., .mov, mp4, .wmb) and presentation (e.g., .ppt, .pptx, .key). **CONTENT FOCUS** The focus is that data storage impacts the accessibility of information and that different data types are stored in different formats. **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 Communication**
DA.VC.4.a Organize data into subsets to provide different views or commonalities and present insights gained using visual or other types of representations.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 3, students extended their knowledge by creating scaled picture and bar graphs. They also created line plots using scales that include whole numbers and fractions (e.g., halves and fourths). In grade 4, students interpret data in self-created graphs to present insights. In grade 5, students will use graphs created to highlight and support a claim they have made. **IMPORTANT CONCEPTS** • A symbol on a graph (picture, bar, etc.) 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 • Data from a graph can be used to gain insights or solve a problem **KEY SKILL/PROCEDURES** • Record data with several categories on a scaled bar graph or picture graph • Determine appropriate scale for data given • Interpret and answer questions regarding data presented in a bar or picture graph **Content Elaborations** **CLARIFICATIONS** An important concept for students to begin to understand is that a scale is chosen based on data available. Students should begin understanding that data is used to solve problems. For example, if the majority of people report they do not recycle due to lack of recycling bins, we can conclude that providing recycling bins to people will increase recycling and improve the environment. **CONTENT FOCUS** The focus is on students using a visual representation to communicate the data they have collected and interpreting the data to answer questions.

Strand	**Data and Analysis**
Topic	**Visualization and Communication**
	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.4.a Utilize data to make predictions and discuss whether there is adequate data to make reliable predictions.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students analyzed and explained relationships or patterns and predicted an unknown. In grade 4, students determine if adequate data has been collected and run simulations to explore outcomes. In grade 5, students will run simulations to test theories and make predictions about how larger data sets effect outcomes.

IMPORTANT CONCEPTS

- Data from a graph can be used to determine patterns
- Patterns can be analyzed to determine a missing value and predict outcomes
- A data set can be modified to manipulate outcomes
- Analyze trends based on quantity of data sets
- Key Skill/Procedures
- Answer questions about missing variables in a data set
- Use data to make predictions about outcomes
- Manipulate data and explain how quantity affects outcomes

Content Elaborations

CLARIFICATIONS

Students explain patterns in data and identify missing values. They begin to manipulate data and reflect on how the quantity of data affects outcomes. Students will use software tools such as spreadsheets to manipulate the quantity of data and reflect on changes that occur.

CONTENT FOCUS

The focus is on students identifying patterns in data to find missing values. They predict outcomes to continue patterns.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

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

Strand	Algorithmic Think and Programming
Topic	**Algorithms**

ATP.A.4.a Construct and refine an algorithm to accomplish a given task.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students experienced designing algorithms. In grade 4, students refine an algorithm to accomplish a given task. In grade 5, students will compare and refine algorithms with a focus on efficiency.

IMPORTANT CONCEPTS

- An algorithm is a series of steps to complete a process or task
- Once algorithms are created and written, they need to be tested and possibly revised based on the results
- Pseudocode and flowcharts can be used to create and modify an algorithm

KEY SKILL/PROCEDURES

- Utilize logical patterns of progression within an algorithm to modify it to accomplish a given task
- Recognize and identify errors within an algorithm to modify it to accomplish a given task
- Utilize pseudocode and flow charts to assist with creating and modifying an algorithm to accomplish a given task

Content Elaborations

CLARIFICATIONS

Processes of computational thinking (i.e., logical thought) or beginning, middle, end to create organized steps should be emphasized in order to decompose, abstract, and reassemble an algorithm. Use proper editing for modifying algorithms (i.e., conditional, loops). Computational thinking also needs to be emphasized to identify where an error has occurred and the process needed to fix it. This can be written in code, pseudocode, real language, or flowcharts.

CONTENT FOCUS

The focus is on students modifying the algorithm to fix it and reconstruct it to accomplish a given task.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems
    2. Decompose real-world problems.

Strand	Algorithmic Think and Programming
Topic	**Variables and Data Representation**
ATP.VDR.4.a Identify and use a variable, a placeholder for storing a value, to understand how it works in a multi-step process (i.e., algorithm).	## Expectations for Learning **LEARNING PROGRESSION** In grade 3, students defined and identified variables to understand how they are used in algorithms. In grade 4, students further expand on defining and identifying variables and begin to use them. In grade 5, students will create a variable to store and modify data. **IMPORTANT CONCEPTS** • Letters or symbols are used to represent a variable within an algorithm • Data can be stored in the variable • Variables represent a changing value **KEY SKILL/PROCEDURES** • Explain and identify variables within algorithms • Write an algorithm that substitutes a variable for a value • Edit the algorithm to show how it changes the algorithm's result ## Content Elaborations **CLARIFICATIONS** Symbols such as letters are used in programming to hold values. Students need to learn that the syntax (i.e., the order of symbols in the equation) may impact the success of a program. Students can explore what happens when the data stored in a variable is changed. For example, a cloze activity allows students to choose varying words for a single blank within a passage. Students would examine how this changes the meaning of the 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."

Strand	**Algorithmic Think and Programming**
Topic	**Variables and Data Representation**
	CONTENT FOCUS The focus is on students being able to define and identify unknown variables as symbols, such as letters, and understanding how they are used in algorithms to store data. Students should begin using variables within equations. **COMPUTER SCIENCE PRACTICES** *Practice 4*. Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena.

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

ATP.CS.4.a Create a program using sequences, events, loops and conditionals to solve a problem.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students built upon their skills and knowledge to create programs with more refined strategies, such as loops and conditionals, and considered the components of an event. In grade 4, students continue to refine their programming skills using established structures such as loops and conditionals. In grade 5, students will apply these new skills in increasingly complex ways and will continue to refine these to work towards programming efficiency.

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 with it
- Proper sequencing of steps within the program ensures efficiency

KEY SKILL/PROCEDURES

- Insert a loop in a program in order 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 its events and products
- Combine statements to make length of code shorter (i.e. if/else/then)

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.

Strand	Algorithmic Think and Programming
Topic	**Control Structures**
	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 as a result of an action. Such as, "When I click the mouse, the image rotates." 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** The focus is on students using a loop, conditional, and/or event. Students should also diagram or describe the flow of a program. The complexity of the loops, conditionals, events, and sequences continues to increase from the prior grade level. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena.

Strand	Algorithmic Think and Programming
Topic	**Modularity**

ATP.M.4.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

In grade 3, students experienced decomposing abstractions into sequences to design algorithms. In grade 4, students continue to refine the decomposition, abstraction and algorithm creation process. In grade 5, students will begin to compare and refine multiple algorithms for efficiency.

IMPORTANT CONCEPTS

- Modularity refers to components of programs that complete a procedure or task. Modules within a program may need to be evaluated, refined and/or copied

KEY SKILL/PROCEDURES

- Utilize logical patterns of progression within an algorithm to make the best use of a series of steps to decompose the algorithm into functional sections
- Regroup or redesign sets of a decomposed algorithm in order to modify the result of the algorithm
- Determine if the logic of an algorithm requires decomposition or abstraction
- Utilize pseudocode and flow charts as related to the algorithm

Content Elaborations

CLARIFICATIONS

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

CONTENT FOCUS

The focus is on students using computational thinking as they work through an algorithm and then breaking an algorithm into its smaller components (i.e., parts) and logically determining if an error has occurred somewhere within an algorithm.

Strand	Algorithmic Think 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 situation 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 Think and Programming
Topic	**Program Development**

ATP.PD.4.a Use a design process to plan and develop a program that addresses a multi-step problem.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students began to design and create a program to solve a problem. In grade 4, students design and create a program for a multi-step problem. In grade 5, students will design and create a program that addresses a multi-step problem and 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
- Programs can execute multiple steps

KEY SKILL/PROCEDURES

- Design a program that can solve a problem
- Use the design process when planning a program
- Create a program for a multi-step problem

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.

Multi-step problems will ask the user to complete 2 or more tasks.

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

CONTENT FOCUS

The focus is on designing a program that can solve a problem with 2 or 3 steps.

Strand	Algorithmic Think 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, taking into account 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 Think and Programming
Topic	**Program Development**

ATP.PD.4.b Using guided questions, work through a program to identify errors and discuss possible solutions to repair the program.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, guided questions were asked to help students think more strategically about how to solve a problem in their program. In grade 4, students continue with guided questions that assist them in debugging their program. In grade 5, students will become less dependent upon guided questions and will begin to debug more complex programs.

IMPORTANT CONCEPTS

- A computer bug is a series of commands that do not properly interact with each other and causes interruptions in the program execution (i.e., 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" 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.

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

Program complexity increases from grade level to grade level.

CONTENT FOCUS

The focus is on locating errors in a block-based environment program and through guided questioning determining solutions and applying the fix.

COMPUTER SCIENCE PRACTICES

Practice 6. Testing and Refining Computational Artifacts

2. Identify and fix errors using a systematic process.

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.4.a List examples of computing technologies that have changed the global community to express how those technologies influence and are influenced by cultural practice.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 3, students identified the impact technology has on everyday life in the local community. In grade 4, students recognize the impact of technology on the global community. In grade 5, students will explain how technology has changed everyday life globally. **IMPORTANT CONCEPTS** • People within a local region use technology in various ways • Daily life is influenced by the technology within the community **KEY SKILL/PROCEDURES** • Identify specific types of technology used in the global community • Describe ways that various technology resources impact daily life in a region **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 in daily life and the influence of cultural practices within the community. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspective of others and reflect on one's own perspectives when designing and developing computational products.

Strand	Impacts of Computing
Topic	**Culture**
IC.Cu.4.b Identify and anticipate diverse user needs to increase accessibility to all users.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 3, students identified diverse user needs and how computing devices have features built in to increase accessibility. In grade 4, students identify and anticipate diverse needs and ways to improve devices to make them more accessible to users. In grade 5, students will modify artifacts to meet diverse user needs to increase accessibility. **IMPORTANT CONCEPTS** • Users have diverse needs that impact accessibility • Computing devices have built in features to increase accessibility **KEY SKILL/PROCEDURES** • Locate and use built in features to increase accessibility • Identify the diverse needs of users **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. Example of built-in feature to increase accessibility include voice command, text-to-speech, and magnify text. (CSTA K-12 Computer Science Standards, 2017) **CONTENT FOCUS** The focus is on identifying the diverse needs of users to increase 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.4.a Collaborate and consider diverse perspectives to improve digital artifacts.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students collaborated through feedback and reflection to improve a digital artifact and begin to explore how diverse perspectives improve digital artifacts. In grade 4, students collaborate with others to share the workload, increase diverse perspectives, and improve a digital artifact. In grade 5, students will collaborate with others outside of the classroom to share the workload, increase diverse perspectives, and improve the 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 them improve the quality of their work
- Sharing the workload with peers can increase productivity and improve the quality of artifacts

KEY SKILL/PROCEDURES

- Leave thoughtful feedback for peers that will help improve their digital artifacts
- Reflect on feedback from peers to improve digital artifacts
- Work with a partner or group to produce a digital artifact

Content Elaborations

CLARIFICATIONS

Teachers can support students to leave thoughtful feedback through modeling this process. Teachers should conduct whole group discussions after students have left feedback to determine if feedback was productive.
As students collaborate, they should begin to understand that group members take on agreed-upon roles to share the workload.

CONTENT FOCUS

The focus is on collaborating as a group to produce digital artifacts. Students begin to understand that feedback can be provided to improve artifacts during the creation process.

Strand	Impacts of Computing
Topic	**Social Interactions**
	COMPUTER SCIENCE PRACTICES *Practice 2.* Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities. 2. Create team norms expectation and equitable workloads to increase efficiency and effectives. 3. Solicit and incorporate feedback from and provide constructive feedback to team members and other stakeholders. 4. Evaluate and select technological tools that can be used to collaborate on a project.

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

IC.SLE.4.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 grade 3, students were 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 are introduced to formal procedures used when sharing materials. Students will be expected to identify the type of source and give credit to the source. In grade 5, students will apply proper procedures when giving credit to a 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
- Sources can be cited formally or informally to give credit for the use of these materials

KEY SKILL/PROCEDURES

- Determine whether a source can or cannot be used freely
- Informally site sources

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 needs to be cited properly.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	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.4.b Explain why information should be shared or kept private to protect student identity.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 3, students learned the importance of keeping personal information secure. In grade 4, students start to make distinctions between what information should be shared and what information should be kept private. In grade 5, students will begin to consider the effects of sharing private information. **IMPORTANT CONCEPTS** • For safety and security, personal information should be kept private **KEY SKILL/PROCEDURES** • Determine whether information should or should not be shared • 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 number, 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 why some information can be shared and some 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.4.c Communicate the importance of protecting one's own digital footprint.

Expectations for Learning

LEARNING PROGRESSION

In grade 3, students were exposed to the vocabulary relating to information security and formed a basic understanding of a digital footprint. In grade 4, students consider how their current online behavior affects their digital footprint. In grade 5, students will expand on the subject by further examining their online behaviors and how they affect others.

IMPORTANT CONCEPTS

- Students already have a digital footprint and continue to add to it with online behavior
- Sites that students are currently using are storing personal information
- Sites that collect digital information store personal information for an infinite amount of time

KEY SKILL/PROCEDURES

- List examples of what would be included in a personal digital footprint
- Give examples of personal information that is appropriate to share
- Determine the impact of contributions to your digital footprint

Content Elaborations

CLARIFICATIONS

Students should begin to consider their own digital footprint and have discussions about the specific impacts of sharing different types of content on one's digital footprint.

CONTENT FOCUS

The focus is on considering specific examples of safe practices regarding online sharing and having students consider their own online actions.

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.

GRADE 5

Strand	Computing Systems
Topic	**Devices**
CS.D.5.a Explore the internal parts of the computing system and their function to understand and describe the role they play in a computer system.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 4, students developed their understanding of what external components are used to share information. In grade 5, students develop their understanding of the internal parts of the computer and how they play a role in the computer system. In grade 6, students will apply knowledge to identify the benefits and limitations of devices. **IMPORTANT CONCEPTS** • Different internal parts of a computer have different purposes • Each internal component has a different function in a computer system **KEY SKILL/PROCEDURES** • Identify key internal components (i.e., parts) such as RAM, hard drive, CPU, motherboard, etc. • Describe the function of each of the key internal components • Describe the internal components of the selected device **Content Elaborations** **CLARIFICATIONS** Internal components (i.e., parts) at this grade level focus upon RAM, hard drive, CPU and the motherboard. Students do not need to have an in-depth understanding of these. **CONTENT FOCUS** The focus should be upon students understanding the role major internal components (i.e., parts) play in a computing system. Unlike external components which are not all needed in order for a device to function, internal components are critical to the device running properly. **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/Software**
CS.HS.5.a Evaluate digital learning tools/devices to support planning, implementing and reflecting across curricular areas.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 4, students continued to select learning tools/devices and used them to aid in planning, implementing, and reflecting on given tasks. In grade 5, students use and evaluate the digital learning tools and devices they've chosen and consider the planning, implementing, and reflecting across curricular areas. In grade 6, students will look at the ways hardware and software components come together in a computer system to complete a task. **IMPORTANT CONCEPTS** • Software and hardware need to be chosen and evaluated to ensure they support the task • Learning tools should be used for planning, implementing, and reflecting across curricular areas **KEY SKILL/PROCEDURES** • Verbally evaluate the tools and devices chosen to accomplish tasks for their usefulness in planning, implementing, and reflecting • Use and verbally evaluate tools across curricular areas **Content Elaborations** **CLARIFICATIONS** Students should recognize if the tool or device they have chosen is appropriate for the task. For example, if the assignment is to make a presentation, a word processing program would not be the best selection. Tasks should be cross-curricular (i.e. blending math, science, and computer science, tasks which require an analysis of data from science or social studies). **CONTENT FOCUS** The focus is on students using and evaluating tools in cross-curricular tasks. **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.5.a Diagnose problems and develop strategies to resolve technology issues.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students focused on diagnosing and describing potential hardware and software problems. In grade 5, students work to diagnose problems, describe the problem, and develop strategies to resolve technology issues. In grade 6, the problems will become more advanced. It will require the combination of critical thinking skills and basic knowledge of computing hardware and software to identify the problem.

IMPORTANT CONCEPTS

- Multiple troubleshooting strategies exist for each issue

KEY SKILL/PROCEDURES

- Diagnose problems in hardware and software
- Apply a solution for the problem
- Describe the problem and reason for the problem in detail

Content Elaborations

CLARIFICATIONS

Students are working on diagnosing problems, describing them and applying a solution where appropriate. Students should be able to describe the problem to a peer or adult.
Students should be able to troubleshoot their own problems. Problems may include an unplugged computer, a computer not connecting to the network or a program not loading. Troubleshooting should also occur within individual programs, such as a block-based coding environment or a word processing program.

CONTENT FOCUS

The focus is on students diagnosing problems, describing them, and applying a potential fix.

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.5.a Model how information is broken down to be transmitted and then reassembled to help students gain a better understanding of the internet and networks.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students described how information is broken apart, sent, and received over the internet. In grade 5, students demonstrate how information is broken apart, sent and reassembled when received over the internet. In grade 6, students will explore the protocols (i.e., rules) in transmitting data across the internet.

IMPORTANT CONCEPTS

- Manipulating a URL (i.e., web address) can change what information is accessed
- Information is broken into packets (i.e., parts) at the sending point and reassembled at the receiving point
- Information is sent to specific places based on web addresses

KEY SKILL/PROCEDURES

- Modify a URL (i.e., web address) to access content
- Demonstrate what occurs when a URL is modified
- Use a metaphorical example to describe how information is broken down into parts and reassembled

Content Elaborations

CLARIFICATIONS

Students begin manipulating a URL to access desired information within a site.
Students begin using applications to shorten web addresses for ease of access.
An example of a metaphorical connection students could make to describe how information is transmitted would be a roller coaster ride. The track could be seen as the internet connection and the cars and the people are the information traveling through the connection.

CONTENT FOCUS

The focus is on students modifying a URL, or web address, to reach a specific site and describing how the modification impacts the information accessed. Students model how information is transmitted.

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.5.b Apply knowledge of network addresses, names and rules (i.e., protocols) to discuss real-world scenarios.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 4, students described how different naming techniques are related to the type of information accessed. In grade 5, students apply this knowledge by interacting with networks appropriately and apply these concepts to real-world scenarios. In grade 6, students will continue to apply this knowledge to more advanced concepts of networks. **IMPORTANT CONCEPTS** • Information is broken into parts and reassembled at the end point • The end point is identified by an IP address **KEY SKILL/PROCEDURES** • Use knowledge of top level naming rules (.com, .edu, .gov) as it relates to reliability of information • Explain the fundamental workings of the internet using appropriate terminology (e.g., packets, IP address) **Content Elaborations** **CLARIFICATIONS** Students need to explain the steps required to transmit information over the internet. Students should explain that information is broken into packets, transmitted to another place identified by an IP address and reassembled at the end site, similar to a puzzle being taken apart, given to other people, and assembled somewhere else. Similar to a mailing address and a letter, the IP address serves as the location where information is sent. No discussion of IP address components (i.e., parts) are needed at this level. **CONTENT FOCUS** The focus is on explaining the fundamental workings of the internet. **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.5.a Demonstrate password creation techniques to develop and use a strong password used on personal accounts.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students described personal information and how passwords are used to protect that information. In grade 5, students create, implement, and store secure passwords to protect personal information. In grade 6, students will understand the concerns that information needs to be protected.

IMPORTANT CONCEPTS

- Password creation techniques
- Apply personally created passwords to personal accounts
- Protection techniques of passwords for personal accounts

KEY SKILL/PROCEDURES

- Create secure passwords utilizing password creation techniques
- Build a strong password using password creation techniques
- Apply password protection techniques

Content Elaborations

CLARIFICATIONS

Explain alpha-numerics, symbols, and non-dictionary words.
Use alpha-numerics, symbols and non-dictionary words to build a secure password.
Students often misuse password storage techniques. They need to understand the difference of using an online password storage system, saving passwords on the computer, writing down passwords, or remembering them and the benefits of types of passwords and storage techniques.

CONTENT FOCUS

The focus is on students building strong, secure passwords using password creation techniques and protecting passwords using different protection techniques.

Strand	Networks and the Internet
Topic	**Cybersecurity**
	COMPUTER SCIENCE PRACTICES *Practice 3.* Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. 3. Evaluate whether it is appropriate and feasible to solve a problem computationally.

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

DA.DCS.5.a Gather and organize multiple quantitative data elements using a tool to perform various tasks.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students built upon the use of tools from grade 3 to collect data from multiple sources within a singular topic over time. In grade 5, students begin to select appropriate tools to collect data from multiple sources within a singular topic over time. In grade 6, students will begin to evaluate the validity of data collection tools.

IMPORTANT CONCEPTS

- Keeping an organized record of data from multiple sources, over time, is critical to analyzing data
- Different tools are used to collect different types of data
- Tools impact the accuracy of data

KEY SKILL/PROCEDURES

- Select and use appropriate tools to collect and organize data
- Maintain accurate data from multiple sources, using multiple tools, within a singular topic over a period of time
- Collect data from multiple sources within a singular topic, 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 and charts. Digital organizational resources could include spreadsheets, online graphing programs, etc.
An example of collecting data from multiple sources within a singular topic could be collecting the height of students in three different classes, throughout the school year. Students should select the most appropriate tool for data collection. Students could choose between an online form, table, or simple document.

CONTENT FOCUS

The focus is on students selecting an appropriate data collection tool to improve the accuracy of data.

Strand	**Data and Analysis**
Topic	**Data Collection and Storage**
	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.5.b Compare and contrast file formats to demonstrate the advantages and disadvantages of each.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students began to gain an understanding that different file types may require different storage. In grade 5, students discuss the advantages and disadvantages of different file types. In grade 6, students will make choices about their file formats in order to organize data.

IMPORTANT CONCEPTS

- Different file types can be different sizes
- Different file types have different purposes
- How data is stored impacts accessibility

KEY SKILL/PROCEDURES

- Store data as a specific file type
- Locate and retrieve data on a computing device (i.e. computer)
- Consider file size when sharing and saving data

Content Elaborations

CLARIFICATIONS

Examples of file types would be image (i.e., .jpg, .png, .gif .bmp), document (e.g., .doc, .docx, .pages, .txt), multi-media (e.g., .mov, mp4, .wmb) and presentation (e.g., .ppt, .pptx, .key). For example, when creating a presentation, use slides instead of a document.

Examples of data storage could include saving to a device, local network or the cloud. An example of file size impacting storage is the inability to download an app on a tablet due to lack of storage.

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.

Strand	Data and Analysis
Topic	**Data Collection and Storage**
	CONTENT FOCUS The focus is different file types accomplish different tasks. There are pros and cons in using various file types. **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 Communication**

DA.VC.5.a Organize and present collected data using visual or other types of representations to highlight relationships and support a claim.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students interpreted data in self-created graphs to present insights. In grade 5, students use graphs created to highlight and support a claim they have made. In grade 6, students will look for patterns and communicate relationships between data sets.

IMPORTANT CONCEPTS

- Data from a graph can be used to gain insights or solve a problem
- The way data is interpreted and highlighted from a graph can support or disprove a claim

KEY SKILL/PROCEDURES

- Record data, with several categories, on a scaled bar graph or picture graph
- Determine appropriate scale for data given
- Interpret and answer questions regarding data presented in a bar or picture graph
- Use a visual representation of data (e.g., picture/bar graph, line plot) to support a claim

Content Elaborations

CLARIFICATIONS

An important concept for students is to begin to understand is that a scale is chosen based on data available.
Students should begin understanding that data is used to solve problems. For example, if the majority of people report they do not recycle due to lack of recycling bins, we can conclude that providing recycling bins to people will increase recycling and improve the environment.

CONTENT FOCUS

The focus is on students using a representation of data they have created to support a claim they have made.

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

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

DA.IM.5.a Utilize data to propose cause and effect relationships and predict outcomes.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 4, students determined if adequate data had been collected and ran simulations to explore outcomes. In grade 5, students run simulations to test theories and make predictions about how larger data sets affect outcomes. In grade 6, students will validate or invalidate a prediction about a collection of data. **IMPORTANT CONCEPTS** • Sample size affects outcomes • Trends can be found by analyzing data sets **KEY SKILL/PROCEDURES** • Use data to highlight or propose cause and effect relationships Predict outcomes using a data set • Manipulate data and explain outcomes **Content Elaborations** **CLARIFICATIONS** Students explain patterns in data and identify missing values. They begin to manipulate data and reflect on how the quantity of data affects outcomes. Students will use software tools, such as spreadsheets to manipulate the quantity of data and reflect on changes that occur. **CONTENT FOCUS** The focus is on students identifying patterns in data to find missing values. They predict outcomes to continue patterns. They manipulate the quantity of data and reflect on changes that occur. **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.5.a Evaluate a multi-step process to diagram the proper steps to solve a problem.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 4, students refined an algorithm to accomplish a given task. In grade 5, students compare and refine algorithms with a focus on the end result. In grade 6, students will evaluate a multi-step process to diagram the proper steps to find the most efficient solution. **IMPORTANT CONCEPTS** • An algorithm is a series of steps to complete a process or task • Once algorithms are created and written, they need to be tested and possibly revised based on the results • Pseudocode and flowcharts can be used to create and modify an algorithm **KEY SKILL/PROCEDURES** • Utilize logical patterns of progression within an algorithm to modify and refine the algorithm to efficiently accomplish a given task • Utilize pseudocode and flow charts to assist with communicating, creating and modifying an algorithm to accomplish a given task **Content Elaborations** **CLARIFICATIONS** Students will utilize processes of computational thinking (i.e., logical thought) to sort through, identify errors, and modify algorithms. They will need to utilize communication techniques (i.e., pseudocode, flowcharts) in order to document the potential errors and solutions. **CONTENT FOCUS** The focus is on students determining the necessity of decomposition, abstraction, modification, and reassembly of the algorithm with an emphasis on the resulting algorithm. Students should utilize communication strategies to further refine their 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.5.a Create 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 4, students expanded on defining and identifying variables. In grade 5, students create variables to store and modify data. In grade 6, students will identify unknown values that need to be represented by a variable within a multi-step process.

IMPORTANT CONCEPTS

- Variables are placeholders for values that can be used in an algorithm
- Data can be stored in the variable
- Variables can represent multiple pieces of information from multiple lines
- Coding language places the variable at the front of the algorithm

KEY SKILL/PROCEDURES

- Use logical variable representations (i.e., letter or symbol)
- Write or edit an algorithm that substitutes a variable for a value
- Edit the variable to show how it changes the algorithm's result
- Determine if a variable is needed within an algorithm

Content Elaborations

CLARIFICATIONS

Symbols such as letters are used in programming to hold values. Students need to learn that the syntax (i.e., the order of symbols in the equation) may impact the success of a program. Students can explore what happens when the data stored in a variable is changed.
For example, using a repetitive nursery rhyme (e.g., Five Little Monkeys), students can create a variable to change the number of monkeys. Here, the changing value is the number of monkeys.

Students are not expected to only use the formal terms of "variable" and "algorithm."

CONTENT FOCUS

The focus is on students being able to define and identify variables as symbols such as letters and understand how they are used in algorithms to store data. Students should begin using variables within equations. Students should explore how variables store data and modify equations.

Strand	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**
	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.5.a Create a program using sequences, events, loops and conditionals to solve a problem.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 4, students refined their programming skills using established structures, such as loops and conditionals. In grade 5, students apply these new skills in increasingly complex ways and will continue to refine these to work towards programming efficiency. In grade 6, students will identify decisions and loops in programs to solve problems. **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 in order to avoid typing a command several times • Insert a conditional in a program in order to make the program more powerful by creating several paths (if/then or if/then/else) • Create an event in the format "When (action), then (result) occurs" • Diagram the flow of a program to demonstrate the sequence of its events and products • Combine statements within other statements (nesting) to make compound statements **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.

Strand	Algorithmic Thinking and Programming
Topic	**Control Structures**
	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 as a result of an action. Such as, "When I click the mouse, the image rotates." 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** The focus is on using a loop to eliminate several redundant commands, using a conditional to add complexity to a program and to program efficiently, creating an event in the format "When (action), then (result) occurs," and diagraming or describing the flow of a program. The complexity of the loops, conditionals, events, and sequences continues to increase from the prior grade level. **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.5.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

In grade 4, students refined the decomposition, abstraction and algorithm creation process. In grade 5, students begin to use abstraction to further refine and design an algorithm. In grade 6, students will utilize decomposition, abstraction, modification and creation of an algorithm to accomplish a given task.

IMPORTANT CONCEPTS

- Modularity refers to components of a program that complete a procedure or task. Modules within a program may need to be evaluated, refined, and/or copied

KEY SKILL/PROCEDURES

- Regroup or redesign sets of a decomposed algorithm in order to modify the result of the algorithm in the most efficient manner possible
- Determine if the logic of an algorithm requires decomposition, abstraction, modification to efficiently accomplish a given task
- Utilize pseudocode and flow charts as related to the algorithm

Content Elaborations

CLARIFICATIONS

Processes of logical thought should include dissection of a whole to its parts. Solving smaller sections of a larger equation to determine its functionality toward the end goal. Ensure that sets of instructions include all needed parts to modify the result to reach the end goal. These instructions can be written in code, pseudocode, real language or flowcharts related to the language of the algorithm.

CONTENT FOCUS

The focus is on students utilizing processes of logical thought, decomposing the algorithm and abstracting, modifying, and reassembling it to accomplish a given task in the most efficient means possible. Students need to utilize communication strategies to document and reduce the algorithm to the most efficient result.

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 situation 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	**Modularity**

ATP.M.5.b With grade appropriate complexity, modify, remix or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students modified and elaborated the portions of code used in their own programs. In grade 5, students use portions of code to develop something new based on a given problem. In grade 6, students will be able to identify the parts of the program they designed.

IMPORTANT CONCEPTS

- Smaller portions of code should be grouped together so the end result will complete a task. These small portions should accomplish a task from start to finish independently of any other sections of code. These sections of code can then be reused to create a new program to solve a problem

KEY SKILL/PROCEDURES

- Break down steps into repeatable chunks
- Use chunks to repeat steps to accomplish a given task
- Create a program using chunked code

Content Elaborations

CLARIFICATIONS

Chunks of code can be grouped together, named, and used as a module (method, class, function) to build a new or modified version of a program (i.e., grouping a set of code used accomplish the task of climbing stairs into a module that can be used anytime stairs need to be climbed).

CONTENT FOCUS

The focus is on students using chunks of code (i.e., modules), repeating, and reorganizing them to create a new program to solve a different problem.

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.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**
	Practice 4. Developing and Using Abstractions 3. Create modules and develop points of interaction that can apply to multiple situation 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.5.a Use a design process to plan and develop a program that includes multiple steps and end user preferences.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students designed and created a program for a multi-step problem. In grade 5, students design and create a program that addresses a multi-step problem and the preferences of the end user. In grade 6, students will advance in designing and creating their own code-based program using block-based languages. Students may begin using text-based coding to program.

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 build a program
- Programs can execute multiple steps
- The end user's preferences can be considered in the creation of a program

KEY SKILL/PROCEDURES

- Design a program that can solve a problem
- Use the design process when planning a program
- Create a program for a multi-step problem
- Incorporate the preferences of the end user into the 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 should address a multi-step problem.

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

End user preferences are additional components included in the problem.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	CONTENT FOCUS The focus is on designing a program that can solve a problem with 3 or more steps and incorporating the preferences of the end user. **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, taking into account 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.5.b Using guided questions, work through a program to identify errors and discuss possible solutions to repair the program.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students continued with guided questions that assisted them in debugging their program. In grade 5, students become less dependent upon guided questions and begin to debug more complex programs. In grade 6, students will modify and fix their own errors in a block-based environment and will begin the debugging process in a text-based environment.

IMPORTANT CONCEPTS

- A computer bug is a series of commands that do not properly interact with each other and causes interruptions in the program execution (i.e., 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 will not execute properly, programmers often refer to the issue as the program "breaks" or the program has a "bug" 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.

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 errors in a block-based environment program and determining solutions and applying the fix.

COMPUTER SCIENCE PRACTICES

Practice 6. Testing and Refining Computational Artifacts

2. Identify and fix errors using a systematic process.

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.5.a Explain how computing technologies have changed the global community and express how those technologies influence and are influenced by cultural practices.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students recognized the impact of technology on the global community. In grade 5, students explain how technology has changed everyday life globally. In grade 6, students will develop a better understanding of how we connect to people around the world.

IMPORTANT CONCEPTS

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

KEY SKILL/PROCEDURES

- Identify specific types of technology used globally
- Describe ways that various technology resources impact daily life
- Compare and contrast the use of technology and the impacts it has on different communities

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)

Students should begin to realize that the effects of technology on their community or region are not necessarily the same as the effects on other communities or regions. For example, one community may be experiencing the effects of having clean energy (e.g., solar power, wind power), whereas another community may not have the same experience.

CONTENT FOCUS

The focus is on the history and influence of technology in the world.

Strand	Impacts of Computing
Topic	**Culture**
	COMPUTER SCIENCE PRACTICES *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspective of others and reflect on one's own perspectives when designing and developing computational products.

Strand	Impacts of Computing
Topic	**Culture**
IC.Cu.5.b Develop, test and refine digital artifacts to improve accessibility and usability.	**Expectations for Learning** **LEARNING PROGRESSION** In grade 4, students identified and anticipated diverse needs and ways to improve devices to make them more accessible to users. In grade 5, students are modifying artifacts to meet diverse user needs to increase accessibility. In grade 6, students will identify issues of bias and accessibility in the design of existing technologies to address equality and equity in society. **IMPORTANT CONCEPTS** • Users have diverse needs that impact accessibility • Computing devices have built-in features to increase accessibility for all users • Artifacts can be modified to increase accessibility for diverse users **KEY SKILL/PROCEDURES** • Locate and use built-in features to increase accessibility • Identify the diverse needs of users • Modify artifacts to meet diverse needs and to increase accessibility **Content Elaborations** **CLARIFICATIONS** Students may consider using both speech and text when they wish to convey information in a game. They may also wish to vary the types of programs they create, knowing that not everyone shares their own tastes. (CSTA K-12 Computer Science Standards, 2017) **CONTENT FOCUS** The focus is on the diverse needs of users, the impact needs have on accessibility, and the modification of artifacts to improve 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.5.a Collaborate and consider diverse perspectives to improve digital artifacts.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students collaborated with others to share the workload, increase diverse perspectives, and improve the artifact. In grade 5, students collaborate with others outside of the classroom to share the workload, increase diverse perspectives, and improve the artifact. In grade 6, students will analyze and present beneficial and harmful effects of communicating using technology. They will begin to examine their impacts on the global, economic, political, business and cultural interactions.

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 them improve the quality of their work
- Collaborating with others outside of the classroom can provide a different cultural aspect
- People use technology to work together remotely (i.e., different building, city, state, country)

KEY SKILL/PROCEDURES

- Leave thoughtful feedback for peers that will help improve their digital artifacts
- Reflect on feedback from peers to improve digital artifacts
- Collaborate with others digitally (i.e., different building, city, state, country), to improve an artifact

Content Elaborations

CLARIFICATIONS

Seeking feedback from people from diverse backgrounds and geographical areas can provide insights for improving a project.

Students can collaborate digitally through various means, such as online video chats, docs, and surveys/forms, and social networking sites.

CONTENT FOCUS

The focus is on collaborating digitally with people from diverse backgrounds and geographic areas.

Strand	Impacts of Computing
Topic	Social Interactions
	COMPUTER SCIENCE PRACTICES *Practice 2.* Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities. 2. Create team norms expectation and equitable workloads to increase efficiency and effectives 3. Solicit and incorporate feedback from and provide constructive feedback to team members and other stakeholders. 4. Evaluate and select technological tools that can be used to collaborate on a project.

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

IC.SLE.5.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 grade 4, students were introduced to more formal terminology used when evaluating the sharing of resources. Students identified the type of source and give credit to the source. In grade 5, students apply proper procedures when giving credit to a source. In grade 6, students will be exposed to a broader range of resources that must be given proper credit.

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
- Sources must be cited formally to give credit for the use of materials
- Citations should consider copyright, Creative Commons, fair use, open source, etc.

KEY SKILL/PROCEDURES

- Determine whether a source can or cannot be used freely
- Use proper format to cite online sources

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 needs to be cited properly.

Strand	Impact of Computing
Topic	Safety, Law and Ethics
	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.5.b Communicate the effects of sharing personal information on the safety of student identity to determine how to protect students.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students started to make distinctions between what information should be shared and what information should be kept private. In grade 5, students consider the effects of sharing private information. In grade 6, students should evaluate shareable information in a more broad context relating to society.

IMPORTANT CONCEPTS

- For safety and security, personal information should be kept private
- Sharing personal information could have a positive or negative effect on a person

KEY SKILL/PROCEDURES

- Determine whether information should or should not be shared digitally
- Recognize that keeping information private protects your identity
- Recognize consequences of sharing too much personal information online as well as the consequences of sharing others' information
- Protect the identity of others by protecting their personal information

Content Elaborations

CLARIFICATIONS

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

CONTENT FOCUS

The focus is on understanding and identifying the consequences of sharing personal information online.

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.5.c Evaluate the need to keep personal information secure and protect the digital footprint.

Expectations for Learning

LEARNING PROGRESSION

In grade 4, students considered how their current online behavior affects their digital footprint. In grade 5, students expand on the subject by further examining their online behaviors and how they affect others. In grade 6, students will describe tradeoffs between allowing information to be public and keeping information private and secure to inform decision making. In addition, they will consider the effect of third parties on their personal information.

IMPORTANT CONCEPTS

- When information is not shared properly, it can become an issue of ethics, safety and security and have an impact on your digital footprint
- Ongoing evaluation of one's digital footprint is important

KEY SKILL/PROCEDURES

- List examples of what would be included in your digital footprint and evaluate the security of what is already a part of your footprint

Content Elaborations

CLARIFICATIONS

Students should evaluate their personal digital footprint and consider the security of their online behavior. If needed, students should take steps to secure online information.
Students should be able to evaluate the security of personal information shared online. For instance, it might be safe to share only a first name, whereas sharing a first name, last name, and birthdate would not be secure or safe.

CONTENT FOCUS

The focus is on making personal connections to online security and social media privacy. Students should evaluate their online and social media activity.

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

GRADES 6-8

GRADE 6

Strand	Computing Systems
Topic	**Devices**
CS.D.6.a Identify the benefits and limitations of a given computing device's functions (including individual components) to explain how the functions and components work together to create the computing system.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students learned about the internal components of a computer. By the end of 6th grade, students apply that knowledge to identify the benefits and limitations of devices. In future grades, students will evaluate devices dependent upon personal needs. **IMPORTANT CONCEPTS** • There are benefits to the functionality of major hardware and software components of a system • Understand how changes in these components will benefit or limit the device **KEY SKILL/PROCEDURES** • Explain the limitations and benefits of devices • Explain the functionality of a component of a system (hardware/software) and describe its benefits or limitations **Content Elaborations** **CLARIFICATIONS** Students will be able to take a particular device and know what it can or cannot do. For example, can a device connect to Wi-Fi, can you print from it, how much memory will this file take up? **CONTENT FOCUS** Students can determine which computing devices can be used for a particular task or to make everyday life easier. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 3. Employ self- and peer-advocacy to address bias in interactions, product design, and development methods

Strand	Computing Systems
Topic	**Hardware/Software**

CS.HS.6.a Identify ways that hardware and software work together as a system to collect and exchange data.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students evaluated the digital learning tools and devices they had chosen across curricular areas. By the end of 6th grade, students look at the ways the hardware and software components come together to collect and exchange data. In future grades, students will evaluate hardware and software components to accomplish a task.

IMPORTANT CONCEPTS

- Identify functionalities of major hardware and software components of a system
- Know a basic flow and order of how the data moves through the components

KEY SKILL/PROCEDURES

- Evaluate input devices and software to determine which combination(s) will produce a proper outcome based on a request
- Identify how the data is input, processed and output

Content Elaborations

CLARIFICATIONS

Consider multiple components, such as functionality, cost, size, speed, accessibility and aesthetics, to select the appropriate hardware or software for a given task. Understand how data moves from input to output in a system.

CONTENT FOCUS

Students can determine computing devices and software that should be used to create an end product and understand how the data flows through the system.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

2. Evaluate existing technological functionalities and incorporate them into new designs.

Strand	Computing Systems
Topic	**Troubleshooting**
CS.T.6.a Use a systematic process to identify and evaluate the source of a routine computing problem. Select the best solution to solve the computing problem and communicate the solution to others.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students worked to diagnose problems, describe the problem, and develop strategies to resolve technology issues. By the end of 8th grade, students will be able to identify and evaluate problems, determine the best solution and also communicate with others to help them solve those problems. In future grades, students will understand the troubleshooting process to evaluate a pre-determined situation. **IMPORTANT CONCEPTS** • Use a basic troubleshooting process • Have a working knowledge of computing devices • Communicate to others via electronic and/or in-person communication **KEY SKILL/PROCEDURES** • Utilize knowledge of computing devices, hardware and software to locate and solve a problem • Create a list of possible solutions to implement • Evaluate solutions to determine the best one • Communicate a solution to others **Content Elaborations** **CLARIFICATIONS** As students gain more experience listing possible solutions, they need to be able to test the solutions and determine the best solution. They also need to learn how to communicate these solutions to others via electronic or in-person communication to help guide others to a solution. **CONTENT FOCUS** Students can identify troubleshooting steps that are key to solving the software/hardware problem. This process involves collaboratively working through the troubleshooting steps.

Strand	Computing Systems
Topic	**Troubleshooting**
	COMPUTER SCIENCE PRACTICES *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 2. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Networks and the Internet
Topic	**Networking**
NI.N.6.a Identify the role of hardware components to understand the infrastructure of networks and the internet (including cloud servers).	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed a general knowledge of how information is broken down to be transmitted over a network. By the end of 6th grade, students understand the flow of information across the hardware of the internet. In future grades, students will identify specific hardware components in the infrastructure of the internet. **IMPORTANT CONCEPTS** • Devices must be connected to the internet to share information • Hardware devices are required to transfer information across the internet • Information travels from router to router across the internet • Servers retrieve (or store) information **KEY SKILL/PROCEDURES** • Explain that the internet is made up of connected devices • Explain that data travels through devices to get from one location to another on the internet **Content Elaborations** **CLARIFICATIONS** Students should understand a simple flow diagram of how information travels from a networked computer across the internet to retrieve information. **CONTENT FOCUS** Students will understand that data travels through devices to get from one location to another location on the internet. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 1. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *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	Networks and the Internet
Topic	**Networking**
NI.N.6.b Identify protocols (i.e., rules) and explain why they are used to transmit data across networks and the internet.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed general knowledge of how information is broken down to be transmitted over a network. By the end of 6th grade, students are able to identify that protocols are rules that define how data between devices is sent and received. In future grades, students will identify specific protocols. **IMPORTANT CONCEPTS** • Devices connected to the internet use protocols • Protocols used for websites include http and https (usage not mechanics) **KEY SKILL/PROCEDURES** • Identify the purpose of protocols • Identify the need for protocols **Content Elaborations** **CLARIFICATIONS** Students should understand that all devices connected to the internet use protocols. **CONTENT FOCUS** Students will understand that hardware combined with software protocols work together to get data from one location to another location on the internet. **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.6.a Identify cybersecurity concerns and measures needed to protect electronic information.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students had experience using and creating a password for a personal account. By the end of 6th grade, students understand the concern that electronic information needs to and can be protected. In future grades, students will learn about encryption to protect information. **IMPORTANT CONCEPTS** • Personal information is valuable information • Social media information is valuable information • Information can be protected from theft and manipulation **KEY SKILL/PROCEDURES** • Identify personal digital habits that help to protect information • Demonstrate software settings to protect information **Content Elaborations** **CLARIFICATIONS** Students will be able to define personal information, such as birthday, address and phone number to explain why it is important that this information is protected (i.e., identify theft). In addition, students will understand what constitutes social media information and explain which information should be shared and which information should remain private. **CONTENT FOCUS** Students will understand that there is personal information that should be kept private for security reasons. Students need to realize not all non-private information needs to be shared via social media. **COMPUTER SCIENCE PRACTICES** *Practice 7.* Communicating about Computing *(Content Statement aligns to Core Practice rather than specific Practice Statements).*

Strand	Networks and the Internet
Topic	**Cybersecurity**

NI.C.6.b Identify the different types of malware to understand threats to data security.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experience using and creating a password for a personal account. By the end of 6th grade, students are able to identify some of the different types of malware that exist that threaten data security. In future grades, students will learn about encryption to protect information.

IMPORTANT CONCEPTS

- Obtain a general understanding of "what is a computer virus?"
- Obtain a general understanding of "what is spyware?"

KEY SKILL/PROCEDURES

- Describe various computer threats, such as how malware is spread via email

Content Elaborations

CLARIFICATIONS

At this level, students will be able to define effective strategies used to safeguard their personal information, such as not clicking on links in email.

CONTENT FOCUS

Students will be able to identify simple measures they can use to protect their personal information.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating about Computing

(Content Statement aligns to Core Practice rather than specific Practice Statements.)

Strand	Networks and the Internet
Topic	**Cybersecurity**
NI.C.6.c Identify ways to protect private information.	## Expectations for Learning **LEARNING PROGRESSION** In previous grades, students had experience using and creating a password for a personal account. By the end of 6th grade, students need to understand private information can be protected by individuals and by software. In future grades, students will have a deeper understanding of how information is protected. **IMPORTANT CONCEPTS** • Access rights include but are not limited to reading, writing, renaming, and deleting files • Software is available to detect and protect information • Shared files and privacy filters are a safety measure • Settings can be accessed to disable options to download and print files **KEY SKILL/PROCEDURES** • Access rights as a security measure • Identify advantages and disadvantages of safety measures ## Content Elaborations **CLARIFICATIONS** At this level, students deepen their understanding of security measures to safeguard online information and documents in various file formats. For example, students should be able to share documents on a shared server, understanding specific security settings. **CONTENT FOCUS** Students will be able to identify how specific software settings (e.g., public vs. private settings) for files can safeguard their data. **COMPUTER SCIENCE PRACTICES** *Practice 7.* Communicating about Computing *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

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

DA.DCS.6.a Identify and use an appropriate digital data collection tool to compile information.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students have explored data sets and are able to define types of data. In 6th grade, students experience collecting data with a specific tool. They develop an understanding that different tools are used to manage specific data. In future grades, students will be able to evaluate the tools that would provide the best solution.

IMPORTANT CONCEPTS

- Use different data capturing tools (e.g., electronic survey, digital thermometer, yard sticks, meter sticks)

KEY SKILL/PROCEDURES

- Identify and use different types of data collection tools that are available
- Select and use the appropriate tool to collect different types of data

Content Elaborations

CLARIFICATIONS

Students need to experience the difference between the use of tools, such as rulers, yardsticks, meter sticks, thermometer, electronic survey, phones, computers and tablets.

CONTENT FOCUS

Students can collect data from individual tools or systems.

COMPUTER SCIENCE PRACTICES

Practice 5. Creating Computational Artifacts

(Content Statement aligns to Core Practice rather than specific Practice Statements.)

Strand	Data and Analysis
Topic	**Data Collection and Storage**
DA.DCS.6.b Select and utilize appropriate file formats to organize collected data.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, student explored files of different types and were able to differentiate the uses of the various types. By the end of 6th grade, students need to know the type of data and how it is stored and select the appropriate type of file. In future grades, students will be able to determine the limitation of various file types. **IMPORTANT CONCEPTS** • Identify picture and text file extensions and the characteristics of these file extensions **KEY SKILL/PROCEDURES** • Explain that not all file extensions are the same • Explain the differences in the quality of the image **Content Elaborations** **CLARIFICATIONS** Students select and utilize the correct file type for various sets of data and text. **CONTENT FOCUS** Students understand the difference between size and quality for various images. Students should have experience with various file formats (e.g., .docx, .GDOC, .xlsx, GSHEET .pdf, .txt, .dat, .gif, .jpg, .tiff, .png, .bmp, .bpg, and other formats). **COMPUTER SCIENCE PRACTICES** *Practice 5.* Creating Computational Artifacts *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

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

DA.DCS.6.c Utilize a file structure to logically organize data to support individual and collaborative work.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, student had experience saving files to a school or portable device. By the end of 6th grade, students know how to organize data, save files and access files, including shared files, on different mediums. In future grades, students will provide more logical structure for storing files. **IMPORTANT CONCEPTS** • Files can be shared • Documents can be organized in folders and subfolders on a hard drive or cloud **KEY SKILL/PROCEDURES** • Utilize procedures for how to share file(s) with others • Explain the importance of files being separated into folders and subfolders based on content • Demonstrate how to follow directions to organize files into folders and subfolders **Content Elaborations** **CLARIFICATIONS** Students need to be able to organize their files within logical structures. (e.g., A contextual example would be using a file cabinet to store folders, notebooks, and papers.) Put folders inside of folders that are labeled appropriately. **CONTENT FOCUS** Students can store files in a system where they can be located at a later time. Students should be able to locate files on the hard drive or cloud. **COMPUTER SCIENCE PRACTICES** *Practice 5.* Creating Computational Artifacts *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	Data and Analysis
Topic	**Visualization and Communication**
DA.VC.6.a Identify and label patterns in models or representations to infer connections between data sets.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, had experience with patterns and collection of information in math classes. By the end of 6th grade, students are able to find patterns in data sets and infer connections between them. Data visualization includes visual, auditory, tactile, oral and other sensory representations. In future grades, students will be able to analyze relationships and patterns between them. **IMPORTANT CONCEPTS** • Identify patterns within a given data set • Compare two or more models or representations (e.g., two graphs or box-and-whisker charts) to discover similarities or trends between them **KEY SKILL/PROCEDURES** • Find patterns and infer connections **Content Elaborations** **CLARIFICATIONS** Given a pair of graphs, student will read the graphs and make comparisons between the two. What is the same? What is different? What story is each telling? **CONTENT FOCUS** Students should be able to read a graph and make comparisons between two graphs. **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 Communication**

DA.VC.6.b Create a spreadsheet utilizing formulas, functions and graphs to represent and analyze data.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, student analyzed graphs in classes. By the end of 6th grade, students recognize that a graph can be created from data using a spreadsheet. In future grades, students will be able to utilize formulas and functions.

IMPORTANT CONCEPTS

- Graphs are a representation of data
- Formulas and functions are used to represent data

KEY SKILL/PROCEDURES

- Explain that data can be used to draw conclusions

Content Elaborations

CLARIFICATIONS

Given a data set, students will construct a graphical representation.

CONTENT FOCUS

Students will be able to recognize pie charts, bar graphs, histograms and other data models. Students will find statistical results, such as mean, median, mode, percentage and degrees in a circle.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating about Computing
1. Select, organize, and interpret large data sets from multiple sources to support a claim.

Practice 5. Creating Computational Artifacts
2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.

Strand	Data and Analysis
Topic	**Inference and Modeling**
DA.IM.6.a Identify and utilize data sets to support or refute a hypothesis.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students should have had experience analyzing data models (e.g., charts, graphs). By the end of 6th grade, students are able to provide evidence to support or refute a prediction about a collection of data. In future grades, students will be able to hypothesize about self-generated data. **IMPORTANT CONCEPTS** • Develop a hypothesis (a prediction) for a problem and then determine if the data collected around the problem supports the hypothesis **KEY SKILL/PROCEDURES** • Given a problem statement, students will be able to create a hypothesis (prediction), collect data (e.g., survey results), analyze a data set and compare the analysis to the hypothesis **Content Elaborations** **CLARIFICATIONS** Students will be given a problem statement and asked to create a hypothesis, collect data, organize the results in an electronic tool, and support or disprove the hypothesis. **CONTENT FOCUS** Students will understand what type of data would be appropriate to help analyze a problem. They should then be able to complete the processes necessary to support or disclaim a hypothesis. **COMPUTER SCIENCE PRACTICES** *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	**Algorithms**

ATP.A.6.a Compare and refine multiple algorithms for the same task to determine which is the most efficient.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students have had experience developing an algorithm for a simple process. At the end of 6th grade, students should be able to choose an algorithm for a multi-step process and evaluate multiple algorithms to determine the most efficient solution. In future grades, students will be able to create algorithms for the most efficient solution.

IMPORTANT CONCEPTS

- Understand the flow of a program
- Compare different sets of pseudocode and determine the most efficient solution

KEY SKILL/PROCEDURES

- Identify the inputs, outputs, processes and decisions

Content Elaborations

CLARIFICATIONS

An algorithm is a series of instructions to obtain a desired result. One example could be a set of directions to travel from the school to the pizza shop or the process of calculating a nine weeks grade. Comparing algorithms can be comparing different set of directions between two locations; all sets of directions end at the same location but one set may be shorter, safer, or have fewer turns. This would be analyzing the algorithms to determine which one is more efficient where efficiency is not necessarily the "fastest" path.

CONTENT FOCUS

An algorithm is a series of instructions to obtain a desired result. One example could be a set of directions to travel from the school to the pizza shop or the process of calculating a nine weeks grade. Comparing algorithms can be comparing different set of directions between two locations; all sets of directions end at the same location but one set may be shorter, safer, or have fewer turns. This would be analyzing the algorithms to determine which one is more efficient where efficiency is not necessarily the "fastest" path.

Strand	**Algorithmic Thinking and Programming**
Topic	**Algorithms**
	COMPUTER SCIENCE PRACTICES *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. *Practice 4.* Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena. 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Strand	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**
ATP.VDR.6.a Identify unknown values that need to be represented by a variable within a multi-step process.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students created variables to store and modify data. By the end of 6th grade, students understand how to use variables in a multi-step process. In future grades, students will be able to understand that variables have different storage requirements and will use parameters. They will learn about scope. **IMPORTANT CONCEPTS** • Identify unknown values in an algorithm **KEY SKILL/PROCEDURES** • Explain the concept of a variable **Content Elaborations** **CLARIFICATIONS** Students will deepen their understanding of variables, including when and how to declare and name new variables. A variable is like a container with a name, in which the contents may change, but the name (identifier) does not. The identifier makes keeping track of the data that is stored easier, especially if the data changes. Naming conventions for identifiers, and thoughtful choices of identifiers, improve program readability. (K-12 Computer Science Framework, 2016) **CONTENT FOCUS** Students should be able to identify variables and be able to explain the advantages of using self-descriptive variable names. They will utilize and understand the importance of self-descriptive variables. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.

Strand	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**
ATP.VDR.6.b Create variables and use them within a multi-step process.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed an understanding of what it means to vary (opposed to being constant) and that this abstract value is expressed with an alphanumeric representation. By the end of 6th grade, students understand how to create and use variables. In future grades, students will be able to understand that variables have different storage requirements and will use parameters. They will learn about scope. **IMPORTANT CONCEPTS** • Create a variable to represent an unknown value **KEY SKILL/PROCEDURES** • Define and utilize a variable in an algorithm **Content Elaborations** **CLARIFICATIONS** At this level, students deepen their understanding of variables, including when and how to declare and name new variables. A variable is like a container with a name, in which the contents may change, but the name (identifier) does not. The identifier makes keeping track of the data that is stored easier, especially if the data changes. Naming conventions for identifiers, and thoughtful choices of identifiers, improve program readability. (K-12 Computer Science Framework, 2016) **CONTENT FOCUS** Students should be able to identify and assign variables. Students should focus on using self-descriptive variable names. Students will utilize and understand the importance of self-descriptive variables. They will create new self-descriptive variables. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.

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

ATP.CS.6.a Identify and trace decisions and loops that exist in a multi-step process within a program.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students applied sequences, events, loops and conditionals in increasingly complex ways. By the end of 6th grade, students are able to identify decisions and loops in programs to solve problems. In future grades, students will understand and incorporate proper processes, loops and conditionals in programs to solve problems.

IMPORTANT CONCEPTS

- Identify the decision structures within an algorithm
- Identify and apply the structures within an algorithm

KEY SKILL/PROCEDURES

- Properly use If-then, if-then-else, and if-then-else if statements
- Properly use Pre-test (do-while), post-test (while) and definite loop (for, for next)

Content Elaborations

CLARIFICATIONS

An example of a nested conditional structure is deciding what to do based on the weather outside. If it is sunny outside, I will further decide if I want to ride my bike or go running, but if it is not sunny outside, I will decide whether to read a book or watch TV. (K-12 Computer Science Framework, 2016)

CONTENT FOCUS

Students at this level will be able to work with single-decision statements, as opposed to nested, and single loops (i.e., iterative processes). Student should be able to identify the decision (if/then) statement(s) and the loop statements (for, while, do) and understand the conditions of when the body of the code (the choice to go running or ride the bike) will be executed and/or how often that code would be executed.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

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

Strand	Algorithmic Thinking and Programming
Topic	**Control Structure**
	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, taking into account key features, time and resource constraints, and user expectations. *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 2. Identify and fix errors using a systematic process.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**

ATP.M.6.a Decompose problems into parts to facilitate the design, implementation and review of programs.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students began to use abstraction to further refine and design an algorithm. By the end of 6th grade, students are able to identify and utilize the procedures/modules within a set of instructions or code. In future grades, students will continue to identify and utilize the procedures/modules within a set of text-based instructions or code.

IMPORTANT CONCEPTS

- Identify smaller components of an algorithm
- Identify a set of steps of an algorithm's component that produces a result

KEY SKILL/PROCEDURES

- Group and organize steps that work together to produce a result
- When provided with an end result, identify the steps that were used

Content Elaborations

CLARIFICATIONS

A procedure is a module (a group of instructions within a program) that performs a particular task. Procedures are invoked to repeat groups of instructions. For example, a procedure, such as one to draw a circle, involves many instructions, but all of them can be invoked with one instruction, such as draw Circle. Procedures that are defined with parameters are generalizable to many situations and will produce different outputs based on a wide range of inputs (arguments). (K-12 Computer Science Framework, 2016)

CONTENT FOCUS

Students will utilize modules to increase the organization of code, the ability to hide details and the reusability.

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.
3. Evaluate whether it is appropriate and feasible to solve a problem computationally.

Strand	**Algorithmic Thinking and Programming**
Topic	**Modularity**
	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. *Practice 6.* Testing and Refining Computational Artifacts 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

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

ATP.PD.6.a Write code that utilizes algorithms, variables and control structures to solve problems or as a creative expression.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students learned how to create a program through block-based programming. By the end of 6th grade, students are able to advance in designing and creating their own block-based programs utilizing parameters. In future grades, students will begin text-based programming.

IMPORTANT CONCEPTS

- Write code to solve a problem using block-based coding software
- Utilize block-based code that has parameters and understand the impact of using different parameter values

KEY SKILL/PROCEDURES

- Use block-based programming
- Use procedures (block-based code) with parameters effectively

Content Elaborations

CLARIFICATIONS

Block-based programming is an accessible entry point for writing code. It teaches fundamental programming skills and encourages experimentation and creativity. Students can "drag" and/or "link" blocks to produce a result, such as animation and picture drawing.

CONTENT FOCUS

Students are to be introduced to a programming language through block-based code. Students should be able to use proper commands to move an object, add to an object, and change the color of an object.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems

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

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	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, taking into account 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.6.b Test and trace to debug and refine code.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students became less dependent on guided questions and began to debug more complex programs. By the end of 6th grade, students are able to identify errors in code and modify and fix errors so that a program will run correctly and produce the expected result. In future grades, students will learn to test and refine programs using a range of text cases.

IMPORTANT CONCEPTS

- Test a variety of solutions within the programming solution
- Identify errors within the program

KEY SKILL/PROCEDURES

- Debug (fix) one's own code

Content Elaborations

CLARIFICATIONS

Students need to understand that errors often occur when writing code. While using block-based coding, students will be able to find errors and make corrections.

CONTENT FOCUS

Students will be able to correct errors when the code will not execute correctly.

Students will experience two types of errors: runtime (this happens when the program "crashes") and logical (this happens when the program is successfully executed but the results were incorrect).

COMPUTER SCIENCE PRACTICES

Practice 6. Testing and Refining Computational Artifacts

1. Systematically test computational artifacts by considering all scenarios and using test cases.
2. Identify and fix errors using a systematic process.

Strand	Impacts of Computing
Topic	**Culture**
IC.Cu.6.a Identify the change that current technologies have on people's everyday activities to understand the impact within a society.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students should have become familiar with some of the ways in which we communicate in today's world. By the end of 6th grade, students begin to develop a better understanding of how we connect to people around the country and the world. Students study how these communication tools impact society. In future grades, students will study the history of computing to evaluate the impact on everyday activities. **IMPORTANT CONCEPTS** • Current technology provides efficiency and convenience for everyday activities • The use of technology increases personal communication and collaboration • Technology has an impact on culture **KEY SKILL/PROCEDURES** • Communicate via school technology with one's parents, class and teacher • Provide feedback to one's peers using existing technologies **Content Elaborations** **CLARIFICATIONS** Students need to understand how today's technology has impacted the amount and speed of information that can be accessed and shared. Students can safely experience this phenomenon through technology provided through their school and/or classroom. **CONTENT FOCUS** Students should list different types of technology they use at school and home, as well as technology that is used in the world around them. Students can identify what they can do with the technology to improve their quality of life. **COMPUTER SCIENCE PRACTICES** *Practice 1*. Fostering an Inclusive Computing Culture *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	Impacts of Computing
Topic	**Culture**
IC.Cu.6.b Identify issues of bias and accessibility in the design of existing technologies to address equality and equity in society.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students need to have developed an understanding that computing has become a global connection. At the end of 6th grade, students understand that even though computing has increased global connections, there are still areas of the world and individuals who do not have the same access. In future grades, students will evaluate technologies for issues of bias and accessibility. **IMPORTANT CONCEPTS** • Computing makes all aspects of our lives more efficient. It gives us the opportunity to communicate on a global scale • Access for those in third world countries is not equitable to those living in many other countries • Computing in the educational setting is not equitable globally or even within our own country • Social economic status impacts access for many in our country • Access may be an issue for persons with disabilities **KEY SKILL/PROCEDURES** • Explain that access is important for everyone regardless of their social economic status, disability or geographic location • Research the issue of accessibility and report out findings **Content Elaborations** **CLARIFICATIONS** The educational system tries to level the computing access playing field for all students, when in reality, not all students have the same opportunities or access once they leave the school setting. Helping students become aware of the world in which they live will help foster citizenship and problem solving (i.e., "thinking outside the box"). Students may experience accessibility limitations personally or observe the bias against a family member or friend. This bias may exist due to disabilities or economic status. Students also need to be exposed to the bias and accessibility issues that many people have globally. **CONTENT FOCUS** Students will be able to understand that computing on a global level is made easier through the efficiency of computing. There is also a disconnect in equity for all students having access to computing. This refers

Strand	Impacts of Computing
Topic	**Culture**
	to accessibility based on socio-economic status, persons with disabilities and third world countries. Students will learn to identify tools that allow equity of accessibility for all students. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 3. Employ self- and peer-advocacy to address bias in interactions, product design, and development methods.

Strand	**Impacts of Computing**
Topic	**Culture**

IC.Cu.6.c Identify and explore careers related to the field of computer science.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students should have had some experience using technology. At the end of 6th grade, students understand that there are many different people and jobs involved in creating the technologies that they utilize. There are a wide variety of computer science careers available and many new careers being developed daily that students should explore. In future grades, students will learn about how computing impacts other career fields.

IMPORTANT CONCEPTS

- It is necessary to stay up-to-date on future industry needs
- Computer science is more than writing code or building a piece of hardware

KEY SKILL/PROCEDURES

- Describe several different existing careers involving computer science and understand that there will be positions in the future that have not yet been defined

Content Elaborations

CLARIFICATIONS

There are many careers under the umbrella of computer science, many of which do not involve coding and building a piece of hardware. Students should be aware of the possibilities that exist today and realize that there will be new jobs for them when they graduate that do not even exist today.

CONTENT FOCUS

Students need to understand that a computer science career is not just writing code, but it is a current and new frontier for careers.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

(Content Statement aligns to Core Practice rather than specific Practice Statements.)

Strand	Impacts of Computing
Topic	**Social Interactions**

IC.SI.6.a Analyze and present beneficial and harmful effects of electronic communications to understand their impacts on interpersonal, global, economic, political, business and cultural interactions.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students collaborated with others to share workload, increase diverse perspectives and improve an artifact. By the end of 6th grade, students can differentiate between the beneficial and harmful effects of technology in a global aspect. In future grades, students will continue to practice safety and proper personal use of devices.

IMPORTANT CONCEPTS

- Identify positive and negative impacts of devices and computing on the health and well-being of businesses, economics, politics and cultural interactions
- Provide examples of beneficial and harmful effects on persons through social media, phones and other devices

KEY SKILL/PROCEDURES

- Differentiate between the harmful and beneficial effects of computing and devices globally and locally on economics, businesses, politics and cultural differences
- Describe ways in which the internet globally impacts business, politics and economics
- Communicate the pros and cons of personal interaction with email, phones and social media
- Describe the advantages and disadvantages of electronic collaboration for interpersonal use

Content Elaborations

CLARIFICATIONS

Computing and devices have a significant impact on connecting with other people, sharing information, and expressing ideas. Students need to understand the power of these devices and differentiate between the beneficial and harmful effects. The economic/business/political uses of these devices can be quantified. The interpersonal effects may be a good transition to an anti-bullying lesson/unit.

CONTENT FOCUS

Students should be able to evaluate how the use of computing devices can contribute or be a detriment to the economics, businesses, politics and cultural differences at the global and local levels. Students also should be able to determine how social media and technological devices can contribute to or have consequences in their daily lives.

Strand	Impacts of Computing
Topic	**Social Interactions**
	COMPUTER SCIENCE PRACTICES *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. *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.6.a Describe tradeoffs between allowing information to be public and keeping information private and secure to inform decision making.

IC.SLE.6.b Identify the social and economic implications of privacy in the context of safety, law or ethics to understand how privacy impacts these areas.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students should have had experience with devices at school. By the end of 6th grade, students understand the difference between public and personal information and the necessity of not sharing personal information. In future grades, students should be able to apply these concepts and continually investigate security concerns and legal rights.

IMPORTANT CONCEPTS

- Identify what is considered to be personal information (e.g., address, phone number, birthdate, social security number, financial information)
- Have a familiarity with some of the "attacks" made by third parties trying to misuse private information

KEY SKILL/PROCEDURES

- Differentiate between personal and public information and make decisions about which items can be safely shared within social media
- Communicate the contents of one's digital footprint
- Recognize third party attempts of retrieving personal information (e.g., emails, phishing)

Content Elaborations

CLARIFICATIONS

Social engineering is based on tricking people into breaking security procedures and can be thwarted by being aware of various kinds of attacks, such as emails with false information and phishing. Security attacks often start with personal information that is publicly available online. All users should be aware of the personal information, especially financial information, that is stored on the websites they use. Protecting personal online information requires authentication measures that can often make it harder for authorized users to access information. (K-12 Computer Science Framework, 2016)

CONTENT FOCUS

Students will be able to identify and understand what information is considered to be personal (e.g., address, phone number, birthdate, social security number, financial information). It is vital that students understand what information should be kept private and secure to protect themselves. Teachers need to

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	reinforce that decisions made regarding their personal information will become a "digital footprint" and be at risk for "attacks" made by third parties trying to misuse private 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.6.c Evaluate the development of new technologies in communication, entertainment and business to understand the impact.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experiences with collaborative documents, school email, electronic grade books and electronic school communication. By the end of 6th grade, students are able to identify some of the positive and negative effects that technology in communication has in the business world, including the entertainment business. In future grades, students will be able to apply these concepts.

IMPORTANT CONCEPTS

- Technology has had a profound effect in the business world

KEY SKILL/PROCEDURES

- Explain how communication in the business world has become faster and easier and has expanded opportunities
- Describe the advantages (e.g., speed and efficiency, communication log, mobile workers)
- Describe the disadvantages (e.g., lack of relationship building, informal communication, distractions)
- Explain why communication must be more deliberate; reacting to electronic messages should be well thought out

Content Elaborations

CLARIFICATIONS

Technology has changed the business world in many ways and perhaps the biggest impact computing has had is in the way businesses communicate. It has expanded the market and business partnerships with companies and allowed for expansion. Overall, this has been a positive impact for businesses and the economy, but it can make communication more distracting and less clear.

CONTENT FOCUS

Students will be able to focus on the positive and negative impacts of computing on the business world.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

(Content Statement aligns to Core Practice rather than specific Practice Statements.)

Strand	Impacts of Computing	
Topic	Safety, Law and Ethics	
		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.6.d Provide appropriate credit when using resources or artifacts that are not our own.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students should have had some experience creating original work that may include code, text, video or graphics. There should have been discussions on citing/providing credit to any sources that are copied/inserted into their work. By the end of 6th grade, students should continue providing credit for all sources. In future grades, students should continue providing credit for all sources.

IMPORTANT CONCEPTS

- Plagiarism/cheating is when you represent someone else's work as your own
- In creating a computational artifact, students can create their own original work, including video, music, text, images, graphs, and program code
- When using external work to integrate into a computational artifact, one must acknowledge, attribute, and/or cite sources and include a bibliography with their submission. External work that should be acknowledged includes video, music, text, images, graphs and programmed code that are used in the creation of computational artifacts

KEY SKILL/PROCEDURES

- Provide proper credit for items inserted into one's work; the credit may be in MLA or APA formatted citations or some other accepted format
- Give credit to not only textbooks, scientific reports and websites, but also to appropriate persons in a collaboration effort

Content Elaborations

CLARIFICATIONS

Ethical complications arise from the opportunities provided by computing. The ease of sending and receiving copies of media on the internet, such as video, photos, and music, creates the opportunity for unauthorized use, such as online piracy, and disregard of copyrights, such as lack of attribution. (CSTA K-12 Computer Science Standards, 2017)

Student need to learn the importance of providing proper credit for all the sources, not only the electronic sources but also those persons with whom they have worked.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	CONTENT FOCUS Students will be able to give appropriate credit for items, such as information, videos and pictures, that they use in their work. **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.6.e Differentiate between the appropriate and inappropriate content on the internet and identify unethical and illegal online behavior.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, most students had some experience finding information on the internet and used the internet for communication. By the end of 6th grade, students should have experience differentiating between appropriate and inappropriate content and behavior on the internet. In the future, students will continue using the internet for communication and be able to identify unethical and illegal online behavior.

IMPORTANT CONCEPTS

- The internet contains sites and information that are for adults only,
- There are sites and programs that have a minimum age requirement
- Students should have permission from adults before using social media
- The internet should not be used for bullying

KEY SKILL/PROCEDURES

- Explain that one should not use sites that encourage vandalism, gambling, crime, terrorism, racism, eating disorders or suicide, nor should they use pictures or videos from the internet which show images of pornography, violence or cruelty to other people or animals.

Content Elaborations

CLARIFICATIONS

Increased computing through numerous devices has increased access globally for all ages. At much younger ages, students have access to the internet through devices such as phones and tablets. Not all information on the internet is appropriate for students and they should be made aware of the dangers of access this information.

CONTENT FOCUS

Students will learn that they should have adult (parent) permission to use devices and that they should report inappropriate information that they may find to an adult.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating About Computing

(Content Statement aligns to Core Practice rather than specific Practice Statements.)

GRADE 7

Strand	Computing Systems
Topic	**Devices**

CS.D.7.a Develop and implement a process to evaluate existing computing devices capabilities based on personal interaction with the device.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students learned about the internal components of a computer. By the end of 7th grade, students use prior knowledge to evaluate devices dependent upon personal needs. In future grades, students will be able to identify improvements to make for a computing device for better interactions with users. **IMPORTANT CONCEPTS** • Select and use appropriate hardware and software components • Create an evaluative process for existing devices **KEY SKILL/PROCEDURES** • Compare similar applications to determine similarities and differences between the applications **Content Elaborations** **CLARIFICATIONS** Students will develop and make comparisons between similar apps and be able to communicate the benefits and limitations of each. **CONTENT FOCUS** Students can determine computing devices that are better fit for completing a task than others. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computation products.

Strand	Computing Systems
Topic	**Hardware/Software**
CS.HS.7.a Evaluate hardware and software combinations used to accomplish a task.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students looked at the ways hardware and software components come together to collect and exchange data. By the end of 7th grade, students use/simulate hardware and software components to accomplish a task. In future grades, students will make decisions on the use of hardware and software combinations to effectively complete a task. **IMPORTANT CONCEPTS** • Select and use/simulate appropriate hardware and software components to accomplish a task with guidance **KEY SKILL/PROCEDURES** • Evaluate input devices and software to determine which combination(s) will produce a proper outcome based on a request **Content Elaborations** **CLARIFICATIONS** Consider multiple components, such as functionality, cost, size, speed, accessibility and aesthetics to select the appropriate hardware or software for a given task. **CONTENT FOCUS** Students can summarize the possible computing device(s) and software to use to produce an outcome based on a requirement provided. **COMPUTER SCIENCE PRACTICES** *Practice 4. Developing and Using Abstractions.* 2. Evaluate existing technological functionalities and incorporate them into new designs.

Strand	Computing Systems
Topic	**Troubleshooting**
CS.T.7.a Use a systematic process to identify and evaluate the source of a routine computing problem. Select the best solution to solve the computing problem and communicate the solution to others.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students worked to diagnose problems, describe the problem and develop strategies to resolve technology issues. By the end of 8th grade, students are able to identify and evaluate problems, determine the best solution and also communicate with others to help them solve those problems. In future grades, students will understand the troubleshooting process to evaluate a pre-determined situation. **IMPORTANT CONCEPTS** • Use a basic troubleshooting process • Have a working knowledge of computing devices • Communicate to others via electronic and/or in-person communication **KEY SKILL/PROCEDURES** • Utilize knowledge of computing devices, hardware and software to locate and solve a problem • Create a list of possible solutions to implement • Evaluate solutions to determine the best one • Communicate a solution to others **Content Elaborations** **CLARIFICATIONS** As students gain more experience listing possible solutions, they need to be able to test the solutions and determine the best solution. They also need to learn how to communicate these solutions to others via electronic or in-person communication to help guide others to a solution. **CONTENT FOCUS** Students can identify troubleshooting steps that are key to solving the software/hardware problem. This process involves collaboratively working through the troubleshooting steps.

Strand	Computing Systems
Topic	**Troubleshooting**

	COMPUTER SCIENCE PRACTICES *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Networks and the Internet
Topic	**Networking**

NI.N.7.a Explain the role of hardware components and diagram the infrastructure of networks and the internet (including cloud servers).

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students developed a very basic understanding of how devices are connected to the internet. By the end of 7th grade, students can diagram specific hardware components used to understand the flow of information across the hardware of the internet. In future grades, students will model specific hardware components in the infrastructure of the internet.

IMPORTANT CONCEPTS

- Multiple devices are required for data to flow on the internet
- Devices connected to the internet must have an address
- Each device has its own role in the flow of data on the internet
- Understanding the role of each device allows the student to diagram the flow of data from one location to another across the internet
- Specific hardware used in networking includes routers and switches

KEY SKILL/PROCEDURES

- Diagram how data travels through devices to get from one location on the internet to others
- Explain the role of key hardware that makes up the internet
- Use knowledge of key hardware to diagram how data might flow from one location to another across the internet

Content Elaborations

CLARIFICATIONS

Students will be able to identify and diagram basic components (e.g., computer, router, server); students can draw lines to make connections of how information travels across the internet.

CONTENT FOCUS

Students will identify specific components used to transfer data on the internet.

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. *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, taking into account 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	Networks and the Internet
Topic	**Networking**
NI.N.7.b Explain the protocols (i.e., rules) and why they are used to transmit data across networks and the internet.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed a very basic understanding of how devices are connected to the internet. By the end of 7th grade, students are able to understand that different protocols are used for different types of data being transmitted between devices. In future grades, students will identify a wider range of protocols used in networking. **IMPORTANT CONCEPTS** • Protocols are used for websites, including http and https (usage not mechanics) • Protocols are used for email, including POP3 and IMAP (usage not mechanics) **KEY SKILL/PROCEDURES** • Identify the purpose of protocols • Identify the need for protocols • Identify how different protocols are used in different situations (http and https) **Content Elaborations** **CLARIFICATIONS** Protocols are rules that define how messages between computers are sent. They determine how quickly and securely information is transmitted across networks and the internet, as well as how to handle errors in transmission. **CONTENT FOCUS** Students will understand the purpose of protocols and how they enable secure and errorless communication. Knowledge of the details of how specific protocols work is not expected. **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.7.a Identify and apply introductory methods of encryption to model the secure transmission of information.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed a general understanding that private information should be protected from malware threats. By the end of 7th grade, students understand that encryption can be used to protect information for secure transmission of information. In future grades, students will understand physical measures to protect information. **IMPORTANT CONCEPTS** • Research the history of encryption • Introduce the concept of encryption and decryption of plaintext • Introduce the technique of Caesar shift (Each letter in the plaintext will be replaced by a letter some fixed number of positions down the alphabet.) **KEY SKILL/PROCEDURES** • Create one's own encryption method • Utilize the Caesar shift to decrypt information **Content Elaborations** **CLARIFICATIONS** Students can explain how encryption can protect the confidentiality of data. Students examine the modifications of different Caesar shift encryptions. In addition, students will create a pattern of encryption based on a Caesar shift and decrypt other students' work. **CONTENT FOCUS** Students will understand encryption effectively protects the confidentiality of data for using secure transmissions. **COMPUTER SCIENCE PRACTICES** *Practice 7.* Communicating about Computing *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	Networks and the Internet
Topic	**Cybersecurity**
	Practice 2. Collaborating Around Computing 1. Cultivating working relationships with individuals possessing diverse perspectives, skills, and personalities. *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.7.b Describe the types of malware to show how malware affects information.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed a general understanding that private information should be protected from malware threats. By the end of 7th grade, students are able to identify additional types of malware that exist that threaten data security. In future grades, students will determine strategies to protect devices. **IMPORTANT CONCEPTS** • Obtain a general understanding of "what is ransomware?" • Obtain a general understanding of "what is spyware?" **KEY SKILL/PROCEDURES** • Recognize malware has many forms **Content Elaborations** **CLARIFICATIONS** In this grade, students will understand malware has many forms and continues to be a challenge for cybersecurity. **CONTENT FOCUS** Students will understand malware is a cybersecurity threat to networks. **COMPUTER SCIENCE PRACTICES** *Practice 7*. Communicating about Computing *(Content Statement aligns to Core Practice rather than specific Practice Statements.)* *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.7.c Identify cybersecurity concerns and measures needed to protect electronic information.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed a general understanding that private information should be protected from malware threats. By the end of 7th grade, students understand how information is protected and where it is needed. In future grades, students will learn about additional encryption algorithms. **IMPORTANT CONCEPTS** • Different protocols can be compared or contrasted (e.g., http versus https) **KEY SKILL/PROCEDURES** • Identify secure communication protocols across the internet **Content Elaborations** **CLARIFICATIONS** In this grade, students should be able to connect how encryption can protect data with https and understand where encryption is needed, such as online banking, versus where it is not, as in a simple online search. **CONTENT FOCUS** Students will understand the connection between encryption and https across the internet. **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.7.a Compare and contrast digital data collection tools to make them more useful and reliable.	## Expectations for Learning **LEARNING PROGRESSION** In previous grades, students had the experience of identifying various data collection tools. By the end of 7th grade, students are able to determine the most appropriate tool(s) to use for data collection. In future grades, students will consistently choose appropriate files types. **IMPORTANT CONCEPTS** • Identify the strengths and weaknesses of various data collection tools **KEY SKILL/PROCEDURES** • Select the appropriate tool for a particular data collection ## Content Elaborations **CLARIFICATIONS** Students will need to know the difference between data collection tools. **CONTENT FOCUS** Students can identify the method of data collection (for example, surveys versus sensor data). The method of data collection can affect the accuracy and precision of the data. (K-12 Computer Science Framework, 2016) **COMPUTER SCIENCE PRACTICES** *Practice 5.* Creating Computational Artifacts *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	Data and Analysis
Topic	**Data Collection and Storage**
DA.DCS.7.b Evaluate various file formats to understand data storage capabilities.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students had limited experience in selecting and utilizing appropriate file type for various collections of text and data. By the end of 7th grade, students should be able to explain and utilize different types of file formats and explain the capacity limits of each file. In future grades, students will learn how data is stored on different computer systems. **IMPORTANT CONCEPTS** • The type of data file corresponds to the type of file format • Identify image and video file extensions and characteristics of file extensions including color, size and visual capabilities • When given an image or video, the student can identify the file format **KEY SKILL/PROCEDURES** • Explain the differences in text and data files • Explain the differences in the quality of the image or video • Explain the type of file extension for various software **Content Elaborations** **CLARIFICATIONS** In addition to the Content Elaborations for DA.DCS.6.b, students need to be able to choose the correct image or video editing software tool for images and videos. **CONTENT FOCUS** Students can create videos of different file types such as wav, webm and mp4. Students should have experience with various file formats (e.g., .docx, .GDOC, .xlsx, GSHEET .pdf, .txt, .dat, .gif, .jpg, .tiff, .png, .bmp, .bpg, .avi, .mov, .mpeg, .mp4, and .wmv and other formats). **COMPUTER SCIENCE PRACTICES** *Practice 2.* Collaborating Around Computing 4. Evaluate and select technological tools that can be used to collaborate on a project.

Strand	Data and Analysis
Topic	**Data Collection and Storage**
	Practice 5. Creating Computational Artifacts *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	Data and Analysis
Topic	**Data Collection and Storage**
DA.DCS.7.c Create a logical file structure to organize data to support individual and collaborative work.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students had experience organizing, saving, accessing, and sharing files. By the end of 7th grade, students are able to understand a logical process for organizing data in folders and subfolders on the hard drive or the cloud. In future grades, students will be knowledgeable with the organization of files and how to properly share them with others. **IMPORTANT CONCEPTS** • Files should be placed in a given organizational system **KEY SKILL/PROCEDURES** • Explain that files should be separated based on content into folders and subfolders **Content Elaborations** **CLARIFICATIONS** Students need to be able to create their own logical file structure. **CONTENT FOCUS** Students understand the importance of organizing their files. Create and utilize shortcuts to their file system (on the desktop, create a shortcut to a file system). **COMPUTER SCIENCE PRACTICES** *Practice 5*. Creating Computational Artifacts *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	Data and Analysis
Topic	**Visualization and Communication**
DA.VC.7.a Communicate relations between data sets to interpret results.	## Expectations for Learning **LEARNING PROGRESSION** In previous grades, students made connections between data sets. By the end of 7th grade, students are able to explain relationships in data models and suggest patterns. Data visualization includes visual, auditory, tactile, oral, and other sensory representations. In future grades, students will be able to utilize raw data and develop models. **IMPORTANT CONCEPTS** • Data models are used to explain and make predictions **KEY SKILL/PROCEDURES** • Suggest patterns by comparing data in the models • Explain the suggested patterns in verbal or written form ## Content Elaborations **CLARIFICATIONS** Given a pair of data models (e.g., graphs, charts), students will identify relationships between the two and suggest patterns that are evident in both models in order to tell the story about what the models are saying. **CONTENT FOCUS** Students will read two or more data models to find relationships and list patterns they see that make sense out of the data. Students should be able to do this using a variety of types of models. **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 Communication**

DA.VC.7.b Create a spreadsheet utilizing formulas, functions and graphs to represent and analyze data.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experience observing graphs created from spreadsheets. By the end of 7th grade, students are able to use formulas and functions in a spreadsheet in order to answer questions and draw conclusions. In future grades, students will use formulas and functions that help represent collections of data.

IMPORTANT CONCEPTS

- Formulas and functions are used to create meaning from a set of data

KEY SKILL/PROCEDURES

- Utilize the formulas and basic functions of a spreadsheet

Content Elaborations

CLARIFICATIONS

Given a data set, students will use functions and formulas in order to make conclusions. (e.g. Given raw data about number and type of pets that their peers own, students will find the average number of pets per family, etc.)

CONTENT FOCUS

Students will be able to use sum, average, min, max and count formulas and functions in a spreadsheet.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating about Computing

1. Select, organize, and interpret large data sets from multiple sources to support a claim.
2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Practice 5. Creating Computational Artifacts

2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.

Strand	Data and Analysis
Topic	**Inference and Modeling**
DA.IM.7.a Create and analyze models and simulations to accurately hypothesize a real-world situation.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students should have had experience analyzing data models (e.g., charts, graphs). By the end of 7th grade, students are able to provide evidence to support or refute a hypothesis (prediction) about a collection of data. In future grades, students will be able to hypothesize about self-generated data. **IMPORTANT CONCEPTS** • Develop a hypothesis for a problem and then determine if the data trend supports the hypothesis **KEY SKILL/PROCEDURES** • Given a problem statement, create a hypothesis (prediction), collect data (e.g., survey results), interpret data trends and compare these interpretations to the hypothesis • Research data trends **Content Elaborations** **CLARIFICATIONS** Students will select a problem statement and be asked to create a hypothesis, collect data, organize the results using an electronic tool, and support or disprove the hypothesis. **CONTENT FOCUS** Students will research and find information that exemplifies data trends. **COMPUTER SCIENCE PRACTICES** *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	**Algorithms**

ATP.A.7.a Select and modify pseudocode for a multi-step process to solve a problem.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students should have developed a basic understanding of what goes into an algorithm and learned how to write pseudocode. As students create an algorithm, they should be able to evaluate the solution and make modifications in their pseudocode to solve the problem. At the end of 7th grade, students should be able to identify the parts of a program's pseudocode (input, output, decisions). In future grades, students will write their own pseudocode and be able to justify the most efficient solution for a multi-step process.

IMPORTANT CONCEPTS

- Understand the flow of a program
- Compare different sets of pseudocode and determine the most efficient solution

KEY SKILL/PROCEDURES

- Identify the inputs, outputs, processes and decisions
- Use proper symbols to create flow charts to represent pseudocode

Content Elaborations

CLARIFICATIONS

Students should be able to write pseudocode to model an algorithm. This could be writing a recipe for making a sandwich, writing directions between two locations, or writing the steps necessary to compute a semester grade.

CONTENT FOCUS

Students should be able to identify the inputs, outputs, and decision steps within the algorithms they create in pseudocode. Students should be able to create a flow chart representation of their pseudocode, using proper symbols for inputs, outputs, and decisions.

COMPUTER SCIENCE PRACTICES

Practice 6. Testing and Refining Computational Artifacts

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

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**
	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 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *Practice 5.* Creating Computational Artifacts 3. Modify an existing artifact to improve or customize it.

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

ATP.VDR.7.a Use test cases to trace variable values to determine the result.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students developed an understanding of what it means to vary (opposed to being constant) and that this abstract value is expressed with an alphanumeric representation. By the end of 7th grade, students understand how to use variables in a test case. In future grades, students will be able to understand that variables have different storage requirements and will use parameters. They will learn about scope.

IMPORTANT CONCEPTS

- Identify top/low range of values that will successfully run a solution
- Identify out of bound values

KEY SKILL/PROCEDURES

- Use Input /output charts

Content Elaborations

CLARIFICATIONS

Students will deepen their understanding of variables, including when and how to declare and name new variables. A variable is like a container with a name, in which the contents may change, but the name (identifier) does not. The identifier makes keeping track of the data that is stored easier, especially if the data changes. Naming conventions for identifiers, and thoughtful choices of identifiers, improve program readability. (K-12 Computer Science Framework, 2016)

CONTENT FOCUS

Students will be able to identify variables and choose appropriate test values for each variable. Students will be able to identify "good" vs. "bad" input values for variables by tracking results on an input/output chart while running test cases.

Strand	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**
	COMPUTER SCIENCE PRACTICES *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. *Practice 4.* Developing and Using Abstractions 3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.

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

ATP.CS.7.a Use and apply decisions and loops in a program to solve a problem.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students need to have learned how to create and utilize self-descriptive variables. Students also need to have learned to identify simple conditionals and loops and to trace the processes. At the end of 7th grade, students understand and incorporate proper processes, loops and conditionals in programs to solve problems. In future grades, students will understand that variables have different storage requirements and restrictions, and are able to choose the correct one to use for a task. Students will use parameters to pass variable information into methods and return values to get information out of a method. Students will be introduced to scope and how a program is able to access or change a variable.

IMPORTANT CONCEPTS

- Utilize and apply the decision structures properly in an algorithm
- Utilize and apply the loop structures properly in an algorithm

KEY SKILL/PROCEDURES

- Properly use If-then, if-then-else, and if-then-else if statements
- Properly use Pre-test (do-while), post-test (while) and definite loop (for, for next)

Content Elaborations

CLARIFICATIONS

Conditional statements can have varying levels of complexity, including compound and nested conditionals. Compound conditionals combine two or more conditions in a logical relationship, and nesting conditionals within one another allows the result of one conditional to lead to another being evaluated. An example of a nested conditional structure is deciding what to do based on the weather outside. If it is sunny outside, I will further decide if I want to ride my bike or go running, but if it is not sunny outside, I will decide whether to read a book or watch TV. Different types of control structures can be combined with one another, such as loops and conditionals. Different types of programming languages implement control structures in different ways. For example, functional programming languages implement repetition

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

	using recursive function calls instead of loops. At this level, understanding implementation in multiple languages is not essential. (K-12 Computer Science Framework, 2016) **CONTENT FOCUS** Students will identify and create compound conditional statements, such as the one described by first choosing the weather: if sunny, then will you go running or biking; else if rainy, will you read or watch TV. Then, the student should include nesting conditions and looping (e.g., Input an integer and if it is even, print a row of "E"s; if it is odd, print a column of "O"s.) **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, taking into account key features, time and resource constraints, and user expectations.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**

ATP.M.7.a Decompose problems into parts to facilitate the design, implementation and review of increasingly complex programs.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experience decomposing an event, experience or problem. For example, in order to create a mural or draw a scene, several "parts" must be chosen first (the background, the characters placed, the action programmed). By the end of 7th grade, students are able to identify and utilize the procedures/modules within a set of instructions or code. Students should also be able to reuse the modules in new problem sets or coding. In future grades, student will be able to utilize the procedures/modules within a set of complex instructions or code.

IMPORTANT CONCEPTS

- Identify smaller components of an algorithm
- Identify a set of steps of an algorithm's component that produces a result
- Reuse the smaller components of the program (modules) in new problem situations

KEY SKILL/PROCEDURES

- Group and organize steps that work together to produce a result
- When provided with an end result, identify the steps that were used
- Reuse the identified module/procedure (organized set of steps) in a new problem situation

Content Elaborations

CLARIFICATIONS

A procedure is a module (a group of instructions within a program) that performs a particular task. Procedures are invoked to repeat groups of instructions. For example, a procedure, such as one to draw a circle, involves many instructions, but all of them can be invoked with one instruction, such as draw Circle. Procedures that are defined with parameters are generalizable to many situations and will produce different outputs based on a wide range of inputs (arguments). (K-12 Computer Science Framework, 2016)

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**
	CONTENT FOCUS Students will be able to utilize modules to increase the organization of code, the ability to hide details, and the reusability. **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. 3. Evaluate whether it is appropriate and feasible to solve a problem computationally. *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. *Practice 6.* Testing and Refining Computational Artifacts 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
ATP.PD.7.a Write code that utilizes algorithms, variables and control structures to solve problems or as a creative expression.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students learned how to use parameters in a block-based programming. By the end of 7th grade, students begin the transition to text-based coding in order to design and create their own project or to solve a problem. They should use procedures that require parameters. In future grades, students will design and create their own text-based programs. **IMPORTANT CONCEPTS** • Write code to solve a problem using programming software that will transition them from block-based to text-based programming **KEY SKILL/PROCEDURES** • Explore programming with software that is intended to transition students from block-based to text-based code • Use procedures containing parameters **Content Elaborations** **CLARIFICATIONS** A transitional programming language will help the student convert to text-based coding. This transitional software will still hide some of the details of coding, automatically fix a few typographical errors, but will allow students to define variables and create control structures. **CONTENT FOCUS** Students should be able to define variables, implement control structures (loops, if/then/else) and use procedures containing variables. **COMPUTER SCIENCE PRACTICES** *Practice 3.* Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. *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, taking into account key features, time and resource constraints, and

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	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.7.b Test, trace and debug to refine code.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students identified and corrected errors in block-based code in order to make the program run correctly and produce the expected result. By the end of 7th grade, students are able to identify and correct two types of errors (run-time and logical) when using a transitional programming language. In future grades, students will continue to refine their programs using a range of text cases. **IMPORTANT CONCEPTS** • Test a variety of solutions within the programming solution • Identify and fix errors within the program **KEY SKILL/PROCEDURES** • Use troubleshooting techniques to debug the code • Debug one's own code **Content Elaborations** **CLARIFICATIONS** Students need to understand that errors often occur when writing code and some of those errors can only be found by verifying that the output is correct. Many transitional programming languages have built-in features to help students identify and correct errors. **CONTENT FOCUS** Students will be able to differentiate between run-time (when a program crashes) and logical (when the results are incorrect) errors and then correct those errors. **COMPUTER SCIENCE PRACTICES** *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 2. Identify and fix errors using a systematic process.

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

ATP.PD.7.c Identify procedures that utilize parameters.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experience using procedures with parameters in block-based coding. For example, there might be a procedure called "move _steps" where the amount of steps is a parameter. By the end of 7th grade, students continue this experience and extend it in a transitional programming language. They are also comfortable with procedures and parameters. In future grades, students will expand their experience with parameters.

IMPORTANT CONCEPTS

- Identify and utilize a procedure and its parameters needed to solve a solution in a transitional text-based programming language

KEY SKILL/PROCEDURES

- Implement a given procedure and use appropriate values for the parameters in a transitional text-based programming language

Content Elaborations

CLARIFICATIONS

At this level, it is appropriate to have students implement canned procedures with parameters in both block-based and text-based programming languages. Examples of procedures for block-based programming languages are: switch costume to ___, go to x:__ y:__, say _ for _ secs. Examples of procedures for text-based languages are: pam.turnLeft(), pam.waddle(), pam.isFish(here), pam.isWater(right). These procedures are canned methods which students implement. Students are not expected to write procedures with return types (methods, functions) from scratch; they are expected to be able to implement them with correct values for the required parameters.

CONTENT FOCUS

Students will understand how to implement canned procedures (methods) with proper parameter values in a text-based programming language.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	COMPUTER SCIENCE PRACTICES *Practice 4.* Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena.

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.7.a Compare current technologies from the present to the past to evaluate the effect on people's everyday activities.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students should have become familiar with ways in which we currently communicate via technology in today's world. At the end of 7th grade, students study the history of computing and technology, including cultural differences, and develop a better understanding of the advancement of computing and its global impact. In future grades, students will study how current technologies affect the economy.

IMPORTANT CONCEPTS

- Examine the change in communication and collaboration styles
- Review the history of computing and technology to understand diversity
- Examine the change in technology skills and tools that are required for the work force

KEY SKILL/PROCEDURES

- Communicate via school technology with one's parents, class and teacher
- Trace the advancement of computing and indicate where globally the advancement has occurred

Content Elaborations

CLARIFICATIONS

Students need to understand how today's technology has increased the amount and speed of information that can be accessed and shared. Students can safely experience this phenomenon through technology provided by their school and/or in their classroom. Students should be able to demonstrate/illustrate the basic timeline of the advancement of computing.

CONTENT FOCUS

Students can compare how a task was accomplished in the past and compare it to how the task is accomplished now, emphasizing how technology has impacted the change.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

(Content Statement aligns to Core Practice rather than specific Practice Statements.)

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.7.b Evaluate various technologies to identify issues of bias and accessibility.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students need to have developed an understanding that computing has become a global connection. At the end of 7th grade, students can identify technologies that have bias and accessibility issues for many areas of the world. There are still areas of the world and individuals who do not have the same access. In future grades, students will propose guidelines to positively impact bias and accessibility.

IMPORTANT CONCEPTS

- Computing makes all aspects of our lives more efficient. It gives us the opportunity to communicate on a global scale
- Bias and accessibility within technology includes third world countries, equity, socio-economic status, and persons with disabilities

KEY SKILL/PROCEDURES

- Explain that access is important for everyone regardless of their socio-economic status, disability or geographic location
- Research the issue of accessibility, identify some of the technologies with this issue and report out their findings

Content Elaborations

CLARIFICATIONS

The educational system tries to level the computing access playing field for all students, when in reality, not all students have the same opportunities or access once they leave the school setting. Helping students become aware of the world in which they live will help foster citizenship and problem solving (i.e., "thinking outside the box"). Students may experience and identify access limitations personally or observe the bias against a family member or friend. This bias may exist due to disabilities or economic status. Students also need to identify the technology bias and accessibility issues that many people have globally.

Strand	Impacts of Computing
Topic	**Culture**
	CONTENT FOCUS Students will determine appropriate technologies for making computing accessible to all. Through research, students will identify a particular need and then determine the appropriate technology or adaptation. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 3. Employ self- and peer-advocacy to address bias in interactions, product design, and development methods.

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.7.c Identify and explore careers related to the field of computer science.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students had experience using technology on personal and/or school devices. They had classroom conversations about a few computer science employment opportunities. At the end of 7th grade, students understand that there are many different people and jobs involved in creating the technology that they utilize and this fact equates into numerous jobs in the computer science fields. In future grades, students will evaluate how new technologies and professions will solve real-world problems. **IMPORTANT CONCEPTS** • It is necessary to stay up-to-date on future industry needs • Computer science is more than writing code or building a piece of hardware • The ever-evolving area of computing will create jobs that do not exist today **KEY SKILL/PROCEDURES** • Describe several different existing careers involving computer science and understand that there will be positions in the future that have not yet been defined **Content Elaborations** **CLARIFICATIONS** There are many careers under the umbrella of computer science, many of which do not involve coding and building a piece of hardware. Students should be aware of the possibilities that exist today and realize that there will be new jobs for them when they graduate that do not even exist today. **CONTENT FOCUS** Students need to understand that a computer science career is not just writing code, but is an integral part of all industry and world culture. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.7.d Explain how computing impacts innovation in other fields.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experiences utilizing several different mediums of technology, such as email, shared school documents, electronic grade books and research on the internet. By the end of 7th grade, students should be able to identify both the positive and negative impact that computing has had in other fields (e.g., robotics in manufacturing, virtual meetings, medical advances). In future grades, students will evaluate how new technologies and professions will solve real-world problems.

IMPORTANT CONCEPTS

- The communication, computation, and connection opportunities provided by computing technologies have provided a wave of innovation in other fields
- Due to current data processing, networking, and computational abilities of computers, we are now able to accomplish things that we had never dreamed possible

KEY SKILL/PROCEDURES

- Identify areas where the benefits of computing technology could be applied to other fields to make them more efficient and/or successful

Content Elaborations

CLARIFICATIONS

The big idea here is that computing is applicable to a wide variety of fields. Students should be given the opportunity to make connections between computing technologies and how they could impact and continue to improve people's lives.

CONTENT FOCUS

Students should have the ability to identify current computing innovations and explore the relationship of how those innovations both positively and negatively affect various careers and other fields of study. Students should study how computing can relate to a variety of careers and explain the advantages and disadvantages of current technologies.

Strand	Impacts of Computing
Topic	**Culture**
	COMPUTER SCIENCE PRACTICES *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.

Strand	Impacts of Computing
Topic	**Social Interactions**

IC.SI.7.a Analyze and present beneficial and harmful effects of electronic communications to understand their impacts on interpersonal, global, economic, political, business and cultural interactions.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had continual conversations with teachers about proper use of electronic devices whenever there was a lesson that involved use of a computing device. In 7th grade, students explore the global, economic, political, business and cultural effects a little more deeply. In future grades, interpersonal use of devices should be a continual conversation and not contained to this single strand.

IMPORTANT CONCEPTS

- Identify positive and negative impacts of devices and computing on the health and well-being of businesses, economics, politics and cultural interactions
- Provide examples of beneficial and harmful effects of persons through social media, phones and other devices

KEY SKILL/PROCEDURES

- Differentiate between the harmful and beneficial effects of computing and devices globally and locally on economics, businesses, politics and cultural differences
- Describe ways in which the internet globally impacts business, politics and economics
- Communicate the pros and cons of personal interaction with email, phones and social media
- Describe the advantages and disadvantages of electronic collaboration for interpersonal use

Content Elaborations

CLARIFICATIONS

Computing and devices have a significant impact on connecting with other people, sharing information and expressing ideas. Students need to understand the power of these devices and differentiate between the beneficial and harmful effects. The economic/business/political uses of these devices can be quantified. The interpersonal effects may be a good transition to an anti-bullying lesson/unit.

CONTENT FOCUS

Students should be able to evaluate how the use of computing devices can contribute or be a detriment to the economics, businesses, politics and cultural differences at the global and local levels. Students also should be able to determine how social media and technological devices can contribute to or have consequences in their daily lives.

Strand	Impacts of Computing
Topic	**Social Interactions**
	COMPUTER SCIENCE PRACTICES *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. *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.7.a Describe tradeoffs between allowing information to be public and keeping information private and secure to inform decision making.

IC.SLE.7.b Identify the social and economic implications of privacy in the context of safety, law or ethics to understand how privacy impacts these areas.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students should have had experience with devices at school and had lessons/teacher conversations about information sharing. By the end of 7th grade, students understand and are able to explain the difference between public and personal information and the necessity of not sharing personal information. In future grades, students should be able to apply these concepts and continually investigate security concerns and legal rights.

IMPORTANT CONCEPTS

- Identify what is considered to be personal information (e.g., address, phone number, birthdate, social security number, financial information)
- Be familiar with some of the "attacks" made by third parties trying to misuse private information
- Identify the consequences of providing misinformation

KEY SKILL/PROCEDURES

- Differentiate between personal and public information and make decisions about which items can be safely shared within social media
- Recognize third party attempts of retrieving personal information (e.g., emails, phishing)
- Communicate the contents of one's digital footprint
- Communicate the implications of providing false or misinformation with devices

Content Elaborations

CLARIFICATIONS

Social engineering is based on tricking people into breaking security procedures and can be thwarted by being aware of various kinds of attacks, such as emails with false information and phishing. Security attacks often start with personal information that is publicly available online. All users should be aware of the personal information, especially financial information, that is stored on the websites they use. Protecting personal online information requires authentication measures that can often make it harder for authorized users to access information. (K-12 Computer Science Framework, 2016)

CONTENT FOCUS

Students will be able to identify and understand what information is considered to be personal (e.g., address, phone number, birthdate, social security number, financial information) vs. public. It is vital that

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	students understand what information should be kept private and secure to protect themselves. Teachers need to reinforce that decisions made regarding their personal information will become a "digital footprint" and be at risk for "attacks" made by third parties trying to misuse private information. Students will additionally be able to understand how the release or sharing of personal information can publicly harm their livelihood or others. **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.7.c Evaluate the development of new technologies in communication, entertainment and business to understand the impact.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experiences with collaborative documents, school email, electronic grade books and electronic school communication. By the end of 7th grade, students are able to identify some of the positive and negative effects that technology in communication has in the business world, including the entertainment business. In future grades, students will be able to apply these concepts

IMPORTANT CONCEPTS

- Technology has had a profound effect in the business world

KEY SKILL/PROCEDURES

- Explain how communication in the business world has become faster and easier and has expanded opportunities
- Describe the advantages (e.g., speed and efficiency, communication log, mobile workers)
- Describe the disadvantages (e.g., lack of relationship building, informal communication, distractions)
- Explain why communication must be more deliberate; reacting to electronic messages should be well thought out.

Content Elaborations

CLARIFICATIONS

Technology has changed the business world in many ways and perhaps the biggest impact computing has had is in the way businesses communicate. It has expanded the market and business partnerships with companies and allowed for expansion. Overall, this has been a positive impact for businesses and the economy, but it can make communication more distracting and less clear.

CONTENT FOCUS

Students will be able to focus on the positive and negative impacts of computing on the business world.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	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. *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.7.d Provide appropriate credit when using resources or artifacts that are not our own.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had some experience creating original work that may include code, text, video or graphics and had discussions on citing/providing credit to any sources that were copied/inserted into their work. By the end of 7th grade, student should continue providing credit for all sources. In future grades, students should continue providing credit for all sources.

IMPORTANT CONCEPTS

- Plagiarism/cheating is when you represent someone else's work as your own
- In creating a computational artifact, students can create their own original work, including video, music, text, images, graphs and program code
- When using external work to integrate into a computational artifact, one must acknowledge, attribute and/or cite sources and include a bibliography with their submission. External work that should be acknowledged includes video, music, text, images, graphs and programmed code that are used in the creation of computational artifacts

KEY SKILL/PROCEDURES

- Provide proper credit for items inserted into their work; the credit may be in MLA or APA formatted citations or some other accepted format.
- Give credit to not only textbooks, scientific reports and websites but also to appropriate persons in a collaboration effort

Content Elaborations

CLARIFICATIONS

Ethical complications arise from the opportunities provided by computing. The ease of sending and receiving copies of media on the internet, such as video, photos and music, creates the opportunity for unauthorized use, such as online piracy, and disregard of copyrights, such as lack of attribution. (CSTA K-12 Computer Science Standards, 2017). Students need to learn the importance of providing proper credit for all sources, not only the electronic sources but also those persons with whom they have worked.

Strand	Impacts of Computing
Topic	Safety, Law and Ethics
	CONTENT FOCUS Students will be able to give appropriate credit for items, such as information, videos and pictures, that they use in their work. **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.7.e Explain the connection between the longevity of data on the internet, personal online identity and personal privacy.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students should have had experience using the internet, school email, school electronic communication and an electronic grade book. Students should have also learned to differentiate between appropriate and inappropriate websites and behavior on the internet and social media. By the end of 7th grade, students understand the tracking that is done while they are electronically communicating and the fact that they leave a "digital footprint." In future grades, students will be able to apply these concepts. **IMPORTANT CONCEPTS** • Identify the type of information contained in a "digital footprint" **KEY SKILL/PROCEDURES** • Identify the data points accessed by apps on a phone (e.g., email, location, phone number, call logs, calendar events) • Identify online tracking with websites, cookies, cross-device tracking, passwords and hotspots. **Content Elaborations** **CLARIFICATIONS** As students access the internet and search online, whether it is via apps on their phones or a web browser on a computing device, they are providing information about themselves. These pieces of information can be equated to puzzle pieces where more pieces are needed in order to complete the picture. Computing devices (e.g., through web browsers and phone apps) collect these puzzle pieces in order to form this complete picture. Students need to be aware of this "digital footprint" that is being collected about them, and they need to investigate strategies to reduce this footprint. **CONTENT FOCUS** Students should focus on the contents of their own digital footprint and what information they leave behind about themselves on the internet.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	COMPUTER SCIENCE PRACTICES *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.

GRADE 8

Strand	Computing Systems
Topic	**Devices**
CS.D.8.a Evaluate the advantages and limitations of existing computing devices to recommend design improvements based on analysis of how users interact with the device.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students learned how to evaluate devices dependent upon personal needs. By the end of 8th grade, students are able to identify improvements to possibly make a computing device for better interaction with users. In future grades, students will be able to extract technological information about computing systems to determine the best practice for situations. **IMPORTANT CONCEPTS** • Identify a problem and make appropriate revisions • Brainstorm ideas to improve a computing device • Hardware defines how the user can interact with the device. **KEY SKILL/PROCEDURES** • Evaluate and communicate the advantages and disadvantages of a computing device **Content Elaborations** **CLARIFICATIONS** Students will work collaboratively and communicate the advantages and disadvantages of computing devices, such as memory limitations. **CONTENT FOCUS** Students can make recommendations to improve a computing device. **COMPUTER SCIENCE PRACTICES** *Practice 6*. Testing and Refining Computational Artifacts 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Computing Systems
Topic	**Hardware/Software**
CS.HS.8.a Design projects that combine hardware and software components that could complete a task.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students used/simulated hardware and software components to accomplish a task. By the end of 8th grade, students make decisions on the use of hardware and software combinations to effectively complete a task. In future grades, students will make decisions on the use of hardware and software combinations to effectively complete a task. **IMPORTANT CONCEPTS** • Research, select and use/simulate appropriate hardware and software components to accomplish a task • Experience the project management process **KEY SKILL/PROCEDURES** • Evaluate hardware and software to determine which combination(s) will produce a proper outcome based on a request • Determine the best hardware and software to use to produce an end result **Content Elaborations** **CLARIFICATIONS** Consider multiple components, such as functionality, cost, size, speed, accessibility and aesthetics to select the appropriate hardware or software for a given task. **CONTENT FOCUS** Students can summarize and recommend the best combination of computing device(s) and software(s) to use to produce an outcome based on a requirement provided. Students will use project management skills as a key tool to effectively complete a task. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions. 2. Evaluate existing technological functionalities and incorporate them into new designs.

Strand	Computing Systems
Topic	**Troubleshooting**
CS.T.8.a Use a systematic process to identify and evaluate the source of a routine computing problem. Select the best solution to solve the computing problem and communicate the solution to others.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students worked to diagnose problems, describe the problem and develop strategies to resolve technology issues. By the end of 8th grade, students are able to identify and evaluate problems, determine the best solution and also communicate with others to help them solve those problems. In future grades, students will understand the troubleshooting process to evaluate a pre-determined situation. **IMPORTANT CONCEPTS** • Use a basic troubleshooting process • Have a working knowledge of computing devices • Communicate to others via electronic and/or in-person communication **KEY SKILL/PROCEDURES** • Utilize knowledge of computing devices, hardware and software to locate and solve a problem • Create a list of possible solutions to implement • Evaluate solutions to determine the best one • Communicate a solution to others **Content Elaborations** **CLARIFICATIONS** As students gain more experience listing possible solutions, they need to be able to test the solutions and determine the best solution. They also need to learn how to communicate these solutions to others via electronic or in-person communication to help guide others to a solution. **CONTENT FOCUS** Students can identify troubleshooting steps that are key to solving the software/hardware problem. This process involves collaboratively working through the troubleshooting steps.

Strand	Computing Systems
Topic	**Troubleshooting**
	COMPUTER SCIENCE PRACTICES *Practice 6*. Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Networks and the Internet
Topic	**Networking**
NI.N.8.a Model the role of hardware components to diagram the infrastructure of networks and the internet (including cloud servers).	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, student developed a basic understanding of how devices and protocols are used in networking. By the end of 8th grade, students are able to develop a model representing networking hardware to understand the flow of information across the internet. In future grades, students should be able to apply these concepts. **IMPORTANT CONCEPTS** • Multiple devices are required for data to flow using protocols on the internet • Each device has its own role in the flow of data on the internet • Understanding the role of each device allows the student to diagram the flow of data from one location to another across the internet • Students should be able to explain concepts, including routers, switches, packets, and protocols **KEY SKILL/PROCEDURES** • Collaboratively create a working model of how data travels through a network, incorporating key hardware components **Content Elaborations** **CLARIFICATIONS** Students will identify basic components (e.g., computer, router, server) where they can create a model to make connections of how information travels across the internet. **CONTENT FOCUS** Students will understand the purpose of hardware and how it enables communication on the internet. **COMPUTER SCIENCE PRACTICES** Practice 2. Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.

Strand	Networks and the Internet
Topic	**Networking**
	Practice 4. Developing and Using Abstractions 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *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, taking into account 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	Networks and the Internet
Topic	**Networking**
NI.N.8.b Model protocols (i.e., rules) and explain why they are used to transmit data across networks and the internet.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed a basic understanding of how devices and protocols are used in networking. By the end of 8th grade, students can identify a wide range of protocols and how they are utilized to transfer data across the internet. In future grades, students will understand a wider range of networking methodologies. **IMPORTANT CONCEPTS** • Protocols are used for websites, including http and https (usage not mechanics) • Protocols are used for email, including POP3 and IMAP (usage not mechanics) • Introduce additional protocols, such as TCP/IP (usage not mechanics) **KEY SKILL/PROCEDURES** • Demonstrate how data is transmitted across networks • Illustrate how data is transmitted **Content Elaborations** **CLARIFICATIONS** At this level, students need to know protocols are used for internet communication on many levels. There are layers of protocols in place to transmit information across the internet. **CONTENT FOCUS** Students will understand that protocols are used and are necessary for communication across the internet. **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.8.c Explain how a system responds when information is lost to understand the effect it has on the transferred information.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed a basic understanding of how devices and protocols are used in networking. By the end of 8th grade, students understand that information that is lost via transmission will be re-transmitted. In future grades, students will learn about retransmission algorithms. **IMPORTANT CONCEPTS** • Understand how information is broken into packets • Lost packets will be re-transmitted • The result of missing packets can mean loss of quality or missing information **KEY SKILL/PROCEDURES** • Utilize a working model to simulate missing packets **Content Elaborations** **CLARIFICATIONS** Students will utilize a working model of basic components (e.g., computer, router, server) to model how protocols are used to transmit information across the internet. **CONTENT FOCUS** Students will understand that hardware combined with specific software protocols work together to get data from one location to another location on the internet. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *Practice 5*. Creating Computational Artifacts 3. Modify an existing artifact to improve or customize it.

Strand	Networks and the Internet
Topic	**Cybersecurity**
NI.C.8.a Explain how physical and digital security measures are used to protect electronic information.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students developed an understanding that encryption is one way to secure information. By the end of 8th grade, students understand physical measures to protect devices and software measures to protect electronic information. In future grades, students will learn different security measures to protect information. **IMPORTANT CONCEPTS** • Be able to safeguard physical devices from theft • Differentiate between physical and digital locks • Password protect all devices **KEY SKILL/PROCEDURES** • Define physical locks (e.g., a locked room or car) • Define software digital locks (e.g., Encryption is a software digital lock) **Content Elaborations** **CLARIFICATIONS** In this grade, students will understand that physical locks, such as a locked car, can protect electronic information in combination with digital locks, such as encryption. **CONTENT FOCUS** Students will understand physical locks and digital locks can be used to protect devices and electronic 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	Networks and the Internet
Topic	**Cybersecurity**

NI.C.8.b Compare and contrast the effects of different types of malware to determine strategies for how to protect devices.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students developed an understanding that encryption is one way used to secure information. By the end of 8th grade, students understand general practices used to identify malware infections. Students can describe how malware can affect information. In future grades, students will learn about removal strategies for malware.

IMPORTANT CONCEPTS

- Follow best practices to password protect all devices
- It is best to use biometrics, when available
- Recognize the symptoms of a malware infection

KEY SKILL/PROCEDURES

- Identify behaviors of malware to determine a possible infection
- Develop strategies for how to protect devices

Content Elaborations

CLARIFICATIONS

Students can identify that malware behaviors, such as reduced speed and pages that will not load, are evidence of infection. Students will understand protection strategies including anti-malware software, regular software updates and common sense (i.e., practice skeptical computing).

CONTENT FOCUS

Students will be able to recognize common behaviors of malware to determine a possible infection on their computer. Students will develop strategies for how to protect devices.

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.8.a Interpret digital data collection tools to manage information effectively.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students worked with data tools and differentiated the appropriate uses of the tools. By the end of 8th grade, students are consistently able to choose and use an appropriate data tool for any given set of data. In future grades, students will be able to understand the benefits of different data collection tools and pick the appropriate one to use for a problem.

IMPORTANT CONCEPTS

- Choose data collection tools for various activities

KEY SKILL/PROCEDURES

- Justify the choice of data collection tool when given a data set

Content Elaborations

CLARIFICATIONS

Students need to be able to choose the correct data collection tool given certain parameters. Students can experience collection of data either individually or collaboratively with at least two types of data sets (e.g., an opinion survey, age survey or height survey).

CONTENT FOCUS

Students can identify types of data that are more difficult to collect than others. For example, emotions must be subjectively evaluated on an individual basis and are thus difficult to measure across a population. Access to tools may be limited by factors including cost, training, and availability. (K-12 Computer Science Framework, 2016)

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

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

Practice 5. Creating Computational Artifacts

(Content Statement aligns to Core Practice rather than specific Practice Statements.)

Strand	Data and Analysis
Topic	**Data Collection and Storage**
DA.DCS.8.b Identify data storage systems to define how data is stored and accessed.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students learned to identify different file types, including video and image. By the end of grade 8, students are able to choose and use an appropriate data tool for any given set of data. Students should be able to explain and utilize different types of file formats. Students understand that files are stored in a root directory on the hard drive or on a network server (in the cloud) with folders and subfolders and be able to appropriately share files. In future grades, students will use data analysis tools. **IMPORTANT CONCEPTS** • Data collection tools can be used to find accurate data to be analyzed • Data analysis tools are used to interpret and investigate the data • There are different ways to represent data in a computer system that have varying costs and benefits **KEY SKILL/PROCEDURES** • Use data analysis tools to organize data and identify trends, patterns and outliers • Select an appropriate data collection tool • Explain how data is stored on different computer systems **Content Elaborations** **CLARIFICATIONS** Students are able to collect data using: • Spreadsheets • qualitative surveys • quantitative surveys • experimental data **CONTENT FOCUS** Students should be able to extract, sort, and filter data into a data storage tool like a spreadsheet, database, or XML file, and using tools to find useful information from the data.

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

	COMPUTER SCIENCE PRACTICES *Practice 4.* Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena. *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.8.c Create a logical file structure to organize data in different storage systems to support individual and collaborative work.	## Expectations for Learning **LEARNING PROGRESSION** In previous grades, students had experience with organizing files in folders and subfolders. By the end of 8th grade, students understand that files are stored in a root directory on the hard drive or in the cloud with folders and subfolders and be able to appropriately share files. In future grades, students will be able to apply these concepts. **IMPORTANT CONCEPTS** • Organize data in a format that is logical to the student's needs **KEY SKILL/PROCEDURES** • Create folders and subfolders on the hard drive or the cloud ## Content Elaborations **CLARIFICATIONS** Students are to create a file system of at least two levels. **CONTENT FOCUS** Students should be able to recognize the structure of directories and pathname of file. **COMPUTER SCIENCE PRACTICES** *Practice 5*. Creating Computational Artifacts *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	**Data and Analysis**
Topic	**Visualization and Communication**

DA.VC.8.a Evaluate data to construct a model or representation.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experience reading and identifying relationships between two models. By the end of 8th grade, students are able to take raw data and make a model from that data. Students are then able to analyze the data in their model to determine patterns. Data visualization includes visual, auditory, tactile, oral, and other sensory representations. In future grades, students will create data visualization artifacts using multiple data sources in order to analyze and answer real-world questions.

IMPORTANT CONCEPTS

- Models are created from a collection of raw data (e.g., survey results that have not been previously organized into any type of chart or graph)
- Analyze a model and determine patterns from raw data

KEY SKILL/PROCEDURES

- Create a variety of types of graphs and find patterns

Content Elaborations

CLARIFICATIONS

Given a set of data, students will select an appropriate type of data model, model the data, read and analyze the model and describe patterns noticed.

CONTENT FOCUS

Students will be able to make data models from different types of graphs. Data models may include line/bar/circle/pictographs, box-and-whisker plots, maps, hierarchical, or relational models.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating about Computing

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

Practice 5. Creating Computational Artifacts.

2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.

Strand	Data and Analysis
Topic	**Visualization and Communication**
DA.VC.8.b Create a spreadsheet utilizing formulas, functions and graphs to represent and analyze data.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students used formulas and functions (canned formulas) in a spreadsheet. By the end of 8th grade, students are able to use functions and formulas and/to create graphs from a spreadsheet that represent collections of data. In future grades, students will evaluate the ability of data visualization artifacts to identify key features and relations by using scientific inquiry, practice and applications. **IMPORTANT CONCEPTS** • Formulas and functions are necessary to create a visual representation of a collection of data **KEY SKILL/PROCEDURES** • Create a representation (charts, graphs) of a collection of data in order to draw conclusions **Content Elaborations** **CLARIFICATIONS** Students will use formulas and functions in a spreadsheet with self-collected data in order to analyze and present results and conclusions. **CONTENT FOCUS** Students will be able to explore (research and collect) data and utilize formulas and functions to visualize results and draw conclusions. **COMPUTER SCIENCE PRACTICES** *Practice 7*. Communicating about Computing 1. Select, organize, and interpret large data sets from multiple sources to support a claim. 2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose. *Practice 5.* Creating Computational Artifacts. 2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.

Strand	Data and Analysis
Topic	Inference and Modeling

DA.IM.8.a Create and analyze models and simulations to accurately hypothesize a real-world situation.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students should have had experience analyzing data models (e.g., charts, graphs). By the end of 8th grade, students are able to provide evidence to support or refute a hypothesis (prediction) about a self-generated collection of data. In future grades, students will construct a model using collected data, create a hypothesis, test it, and refine it to discover connections and trends.

IMPORTANT CONCEPTS

- Develop a hypothesis for a problem and then determine if the data collected around the problem supports the hypothesis

KEY SKILL/PROCEDURES

- Given a problem statement, create a hypothesis (prediction), collect data (e.g., survey results), interpret data trends, compare trends to the hypothesis and analyze data trends
- Compare related data sets

Content Elaborations

CLARIFICATIONS

Students will create a problem statement and hypothesis, collect data, organize and analyze the results using an electronic tool, identify the trends to support or disprove the hypothesis.

CONTENT FOCUS

Students will construct a problem statement and understand what type of data would be appropriate to help analyze their problem. They should then be able to complete the processes necessary to support or disclaim a hypothesis.

COMPUTER SCIENCE PRACTICES

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	**Algorithms**
ATP.A.8.a Create multiple pseudocode to solve a multi-step process and justify the most efficient solution.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students should have developed a basic understanding of what goes into an algorithm and know how to write pseudocode. As students create multiple solutions to a problem, they must be able to analyze various solutions and determine the most efficient. At the end of 8th grade, students should be able to identify the parts of a program's pseudocode (input, output, decisions). In future grades, students will learn how to break a problem into steps, and then in addition to just pseudocode be able to represent the algorithm using process and data flow diagrams. Students will be able to explain the steps of the problem and be able to communicate why they broke the problem down the way they did. Finally, they will be able to implement their created algorithm in an appropriate programming language and optimize it using best practices. **IMPORTANT CONCEPTS** • Understand the flow of a program • Compare different sets of pseudocode and determine the most efficient solution **KEY SKILL/PROCEDURES** • Identify the inputs, outputs, processes and decisions • Use proper symbols to create flow charts to represent pseudocode **Content Elaborations** **CLARIFICATIONS** Student should be able to write more than one pseudocode solution for the same problem (e.g., two different sets of directions between two locations). Then, they should be able to analyze each proposed solution and list the pros and cons of each.

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**
	CONTENT FOCUS Student should be able to identify the inputs, outputs, and decision steps within the algorithms they create in pseudocode. Student should be able to create a flow chart representation for each of their pseudocode solutions, using proper symbols for inputs, outputs, and decisions. **COMPUTER SCIENCE PRACTICES** *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. *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 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes. *Practice 5.* Creating Computational Artifacts 3. Modify an existing artifact to improve or customize it.

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

ATP.VDR.8.a Analyze test cases and determine the range of valid solutions.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students developed an understanding of what it means to vary (opposed to being constant) and that this abstract value is expressed with an alphanumeric representation. By the end of 8th grade, students understand how to use variables and analyze test cases. In future grades, students will be able to understand that variables have different storage requirements and restrictions and be able to choose the correct one to use for a task. Students will also use parameters to pass variable information into methods and return values to get information out of a method. Students will also learn about scope or when the program is able to access or change a variable.

IMPORTANT CONCEPTS

- Identify top/low range of values that will successfully run a solution
- Identify out of bound values

KEY SKILL/PROCEDURES

- Test values in and out of the range of data
- Test value upper, middle and lower range of the data
- Test invalid input (e.g., negative numbers, zero, etc.)

Content Elaborations

CLARIFICATIONS

Students will deepen their understanding of variables, including when and how to declare and name new variables. A variable is like a container with a name, in which the contents may change, but the name (identifier) does not. The identifier makes keeping track of the data that is stored easier, especially if the data changes. Naming conventions for identifiers, and thoughtful choices of identifiers, improve program readability. (K-12 Computer Science Framework, 2016)

CONTENT FOCUS

Students will be able to identify variables and choose appropriate test values for each variable. Students will be able to identify "good" vs. "bad" input values for variables by tracking results on an input/output chart while running test cases. Students will learn to test for cases of invalid input (e.g., values that result in division by zero, square root of a negative value, variable that is blank vs. zero, etc.)

Strand	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**
	COMPUTER SCIENCE PRACTICES *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. *Practice 4.* Developing and Using Abstractions 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Strand	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**
ATP.VDR.8.b Use a data structure to represent a collection.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students created, used and traced variables. By the end of 8th grade, students are able to identify a collection of information that can be represented by a single identifier (data structure). In future grades, students will understand that variables have different storage requirements and restrictions and are able to choose the correct one to use for a task. Students will use parameters to pass variable information into methods and return values to get information out of a method. Students will understand scope, or when the program is able to access or change a variable. **IMPORTANT CONCEPTS** • Create a variable that holds a collection of related values **KEY SKILL/PROCEDURES** • Identify a list of related values that can be categorized and assigned to a variable **Content Elaborations** **CLARIFICATIONS** Using a single variable name, students will be able to create a list of colors where each color has its own defining value(s). **CONTENT FOCUS** Students will understand that one identifier is able to "contain" a list of information. Students will have experience with using a built-in data structure provided by the software. **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.8.a Use and apply decisions and loops in a program to solve a problem.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students developed an understanding of variables and how to use a simple conditional and loop (not compound or nested). By the end of 8th grade, students understand and incorporate proper processes, loops and conditionals in programs to solve problems. In future grades, students will understand that variables have different storage requirements and restrictions and are able to choose the correct one to use for a task. Students will use parameters to pass variable information into methods and return values to get information out of a method. Students will be introduced to scope and how a program is able to access or change a variable.

IMPORTANT CONCEPTS

- Utilize and apply the decision structures properly in an algorithm
- Utilize and apply the loop structures properly in an algorithm
- Utilize and apply nested structures within an algorithm

KEY SKILL/PROCEDURES

- Properly use If-then, if-then-else, and if-then-else if statements
- Properly use Pre-test (do-while), post-test (while) and definite loop (for, for next)

Content Elaborations

CLARIFICATIONS

Conditional statements can have varying levels of complexity, including compound and nested conditionals. Compound conditionals combine two or more conditions in a logical relationship, and nesting conditionals within one another allows the result of one conditional to lead to another being evaluated. An example of a nested conditional structure is deciding what to do based on the weather outside. If it is sunny outside, I will further decide if I want to ride my bike or go running, but if it is not sunny outside, I will decide whether to read a book or watch TV. Different types of control structures can be combined with one another, such as loops and conditionals. Different types of programming languages implement control structures in different ways. For example, functional programming languages implement repetition using recursive function calls instead of loops. At this level, understanding implementation in multiple languages is not essential.

Strand	Algorithmic Thinking and Programming
Topic	**Control Structures**
	CONTENT FOCUS Students will be able to create compound conditional statements such as the one described by first choosing the weather: if sunny then will you go running or biking, else if rainy will you read or watch TV. Then, the student should include nesting conditions and looping (e.g., Input an integer and if it is even, print a row of "E"s; if it is odd, print a column of "O"s.) **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, taking into account key features, time and resource constraints, and user expectations. *Practice 3*. Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**
ATP.M.8.a Decompose problems and subproblems into parts to facilitate the design, implementation and review of complex programs.	## Expectations for Learning **LEARNING PROGRESSION** In previous grades, students had experience decomposing an event, experience or problem. For example, in order to create a mural or draw a scene, several "parts" must be chosen first (the background, the characters placed, the action programmed). By the end of 8th grade, students are able to identify and utilize the procedures/modules within a set of instructions or code. Students should also be able to reuse the modules in new problem sets or coding and pull out the modules for testing. In future grades, student will continue to apply this concept. **IMPORTANT CONCEPTS** • Identify smaller components of an algorithm • Identify a set of steps of an algorithm's component that produces a result • Smaller components of a program (modules) can be reused in new problem situations • Isolate procedures (modules) for testing **KEY SKILL/PROCEDURES** • Group and organize steps that work together to produce a result • When provided with an end result, identify the steps that were used. • Reuse the identified module/procedure (organized set of steps) in a new problem situation • Identify a module and test it ## Content Elaborations **CLARIFICATIONS** A procedure is a module (a group of instructions within a program) that performs a particular task. Procedures are invoked to repeat groups of instructions. For example, a procedure, such as one to draw a circle, involves many instructions, but all of them can be invoked with one instruction, such as draw a circle. Procedures that are defined with parameters are generalizable to many situations and will produce different outputs based on a wide range of inputs (arguments). (K-12 Computer Science Framework, 2016)

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**

CONTENT FOCUS

Students will be able to organize code, hide details and increase reusability. Additionally, procedures increase efficiency and accuracy when testing and debugging.

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.
3. Evaluate whether it is appropriate and feasible to solve a problem computationally.

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.

Practice 6. Testing and Refining Computational Artifacts

3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Algorithmic Thinking and Programming
Topic	Program Development
ATP.PD.8.a Write code that utilizes algorithms, variables and control structures to solve problems or as a creative expression.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students learned how to create a program through block-based and transitional programming. By the end of 8th grade, students are able to design and create their own transitional languages. In future grades, students will learn how software development progresses through a life cycle. **IMPORTANT CONCEPTS** • Write code to solve a problem using a text-based programming language **KEY SKILL/PROCEDURES** • Use text-based code that includes operations, variable definitions and control structures to solve problems **Content Elaborations** **CLARIFICATIONS** Students will write code using a transitional (for students coming from block-based coding or from no experience in any language) text-based programming language. Students will be using operators (add, subtract, multiply, divide), variable definitions, and control structures (for, while, do, if/then/else) in their code in order to solve a problem or create a graphic. **CONTENT FOCUS** Students should be able to define variables, implement control structures (loops, if/then/else) and use procedures containing variables. **COMPUTER SCIENCE PRACTICES** *Practice 3*. Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. *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, taking into account key features, time and resource constraints, and user expectations.

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	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.8.b Systematically test and refine programs using a range of test cases.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experience programming in a transitional programming language. They also had some exposure to finding and correcting errors in a transitional programming language. By the end of 8th grade, students continue to use a transitional programming language and increase the complexity of the code (e.g., nesting conditionals) which will increase the complexity of debugging. Students should be able to identify errors (run-time and logical), modify and test code in order to make the program robust. In future grades, students will use the software development life cycle to refine their programs.

IMPORTANT CONCEPTS

- Compile code to successfully run programming code and produce the expected result
- Test a variety of solutions within the programming solution
- Identify and fix errors within the program
- Understand the meaning of a robust program

KEY SKILL/PROCEDURES

- Use troubleshooting techniques to debug the code
- Debug code
- Differentiate between logical and run-time errors
- Write robust code

Content Elaborations

CLARIFICATIONS

Students need to understand that errors often occur when writing code. Introduce the concept of a robust program. Students need to understand that just because their code did not "crash" and output was produced, there still may be errors in the code, especially if the output is incorrect. Many transitional programming languages have built-in features to help students identify (troubleshoot) and correct run-time errors (debug), but finding the logical errors will take more investigation.

CONTENT FOCUS

Students will produce robust code by differentiating between run-time (when a program crashes) and logical (when the results are incorrect) errors and then, independently, correcting those errors. Students

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
	will create robust code by experiencing and differentiating between two types of errors: runtime (this happens when the program "crashes") and logical (the happens when the program is successfully executed, but the results were incorrect). **COMPUTER SCIENCE PRACTICES** *Practice 6*. Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 2. Identify and fix errors using a systematic process.

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

ATP.PD.8.c Use procedures that utilize parameters to pass values.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students had some experience using procedures with parameters in either block-based or transitional programming languages. By the end of 8th grade, students are experienced using multiple procedures that have one or more parameters in a transitional language. In future grades, students will continue their investigation of procedures by passing multiple parameters and returning values. **IMPORTANT CONCEPTS** • Identify and utilize multiple procedures and their parameters needed to solve a solution in a transitional text-based programming language **KEY SKILL/PROCEDURES** • Implement multiple procedures and use appropriate values for the parameters **Content Elaborations** **CLARIFICATIONS** Students will implement predefined procedures with parameters in text-based programming languages. Students are not expected to write procedures with return types (methods, functions) from scratch; they are expected to be able to implement them with various data types for the parameters. **CONTENT FOCUS** Students will understand how to implement predefined procedures (methods) with proper parameter values in a text-based programming language. **COMPUTER SCIENCE PRACTICES** *Practice 4*. Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena.

Strand	Impacts of Computing
Topic	**Culture**
IC.Cu.8.a Compare current technologies and how they affect the current economy.	## Expectations for Learning **LEARNING PROGRESSION** In previous grades, students should have become familiar with the history of computing and the ways in which we currently communicate via technology. By the end of 8th grade, students develop an understanding of the impact of computing on our country and the global economies. In the future, students will analyze new technologies to predict realistic impacts on society. **IMPORTANT CONCEPTS** • Identify how technology increases efficiency in the work force • Identify how technology contributes to automation/job loss • Technology can result in the need for refitting of the educational requirements for jobs • Technology improves communication and collaboration in the work force • Advancements in technology contribute to new and unknown careers **KEY SKILL/PROCEDURES** • Communicate via school technology with one's parents, class and teacher • Explain the economic impact of the advancement of computing ## Content Elaborations **CLARIFICATIONS** Globalization, coupled with the automation of the production of goods, allows access to labor that is less expensive and creates jobs that can easily move across national boundaries. (K-12 Computer Science Framework, 2016) Students should explore the many pros and cons to this automation and globalization as it pertains to the economy and job market. Students need to learn about the additional learning needed when a worker changes jobs and the challenge of training young students for jobs that do not exist today. **CONTENT FOCUS** Students should consider a specific technology and its impact on the world. Students should discuss the economic impacts of this piece of technology on families, communities, and the world.

Strand	**Impacts of Computing**
Topic	**Culture**
	COMPUTER SCIENCE PRACTICES *Practice 1.* Fostering an Inclusive Computing Culture *(Content Statement aligns to Core Practice rather than specific Practice Statements.)*

Strand	Impacts of Computing
Topic	**Culture**
IC.Cu.8.b Propose potential guidelines/standards/criteria to positively impact bias and accessibility in the design of future technologies.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students need to have developed an understanding that computing has become a global connection. By the end of 8th grade, students can identify technologies that have bias and accessibility issues for many areas of the world and then propose potential guidelines/modifications that would eliminate the bias and increase accessibility for all. In future grades, students will evaluate an alternative solution where a current tool does not exist due to limited resources. **IMPORTANT CONCEPTS** • Computing makes all aspects of our lives more efficient. It gives us the opportunity to communicate on a global scale • Bias and accessibility within technology includes third world countries, equity, socio-economic status, and persons with disabilities **KEY SKILL/PROCEDURES** • Explain that access is important for everyone regardless of their socio-economic status, disability or geographic location • Research the issue of bias and accessibility of computing, identify some of the technologies with this issue and propose guidelines/modifications for improvements **Content Elaborations** **CLARIFICATIONS** The educational system tries to level the computing access playing field for all students, when in reality, not all students have the same opportunities or access once they leave the school setting. Helping students become aware of the world in which they live will help foster citizenship and problem solving (i.e., "thinking outside the box"). Students may experience and identify access limitations personally or observe the bias against a family member or friend. This bias may exist due to disabilities or economic status. This life experience may give them ideas for ways to improve the accessibility. Students also need to identify the technology bias and accessibility issues that many people have globally.

Strand	Impacts of Computing
Topic	**Culture**
	CONTENT FOCUS Students will determine technologies with bias in computing. Through research, students will identify the bias, determine the appropriate technology or adaptation and propose guidelines/modifications for improvements to positively impact bias and accessibility. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 3. Employ self- and peer-advocacy to address bias in interactions, product design, and development methods

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.8.c Identify and explore careers related to the field of computer science.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experience using technology on personal and/or school devices and had several classroom conversations about computer science employment opportunities. At the end of 8th grade, students understand that there are many different people and jobs involved in creating the technology that they utilize and this fact equates into numerous jobs in the computer science fields. In future grades, students will evaluate how new technologies and professions will solve real-world problems.

IMPORTANT CONCEPTS

- It is necessary to stay up-to-date on future industry needs
- Computer science is more than writing code or building a piece of hardware
- The ever-evolving area of computing will create jobs that do not exist today

KEY SKILL/PROCEDURES

- Describe several different existing careers involving computer science and understand that there will be positions in the future that have not yet been defined

Content Elaborations

CLARIFICATIONS

There are many careers under the umbrella of computer science, many of which do not involve coding and building a piece of hardware. Students should be aware of the possibilities that exist today and realize that there will be new jobs for them when they graduate that do not even exist today.

CONTENT FOCUS

The priority is that students need to understand that a computer science career is not just writing code, but is an integral part of all industry and world culture.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

(Content Statement aligns to Core Practice rather than specific Practice Statements.)

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.8.d Explain how computing impacts innovation in other fields.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had experience utilizing several different mediums of technology, such as email, shared school documents, electronic grade books and research on the internet. By the end of 8th grade, students should be able to identify both the positive and negative impact that computing has had in other fields (e.g., robotics in manufacturing, virtual meetings, medical advances). In future grades, students will evaluate how new technologies and professions will solve real-world problems.

IMPORTANT CONCEPTS

- The communication, computation, and connection opportunities provided by computing technologies have provided a wave of innovation in other fields.
- Due to current data processing, networking, and computational abilities of computers, we are now able to accomplish things that we had never dreamed possible

KEY SKILL/PROCEDURES

- Identify areas where the benefits of computing technology could be applied to other fields to make one more efficient and/or successful

Content Elaborations

CLARIFICATIONS

The big idea here is that computing is applicable to a wide variety of fields. Students should be given the opportunity to make connections between computing technologies and how they could impact and continue to improve people's lives.

CONTENT FOCUS

Students should have the ability to identify current computing innovations and explore the relationship of how those innovations both positiviely and negatively affect various careers and other fields of study. Students should study how computing can relate to a variety of careers and explain the advantages and disadvantages of current technologies.

Strand	Impacts of Computing
Topic	**Culture**
	COMPUTER SCIENCE PRACTICES *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.

Strand	Impacts of Computing
Topic	**Social Interactions**

IC.SI.8.a Evaluate the impacts of electronic communication on personal relationships to be able to evaluate differences between face-to-face and electronic communication.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students had continual conversations with teachers about proper use of electronic devices whenever there was a lesson that involved use of a computing device. By the end of 8th grade, students evaluate the pros and cons of face-to-face interactions versus electronic interactions (e.g., emails, phones, social media). In future grades, students will have a continual conversation on interpersonal use of devices and this conversation will not be contained to this single strand.

IMPORTANT CONCEPTS

- Identify positive and negative impacts of devices and computing on the health and well-being of businesses, economics, politics and cultural interactions
- Explain the advantages and disadvantages when comparing electronic meetings with face-to-face meetings
- Provide examples of beneficial and harmful effects on persons through social media, phones and other devices

KEY SKILL/PROCEDURES

- Differentiate between the harmful and beneficial effects of computing and devices globally and locally on economics, businesses, politics and cultural differences
- Describe ways in which the internet globally impacts business, politics and economics
- Communicate the pros and cons of personal interaction with email, phones and social media
- Describe the advantages and disadvantages of electronic collaboration for interpersonal use

Content Elaborations

CLARIFICATIONS

Computing and devices have a significant impact on connecting with other people, sharing information and expressing ideas. Student should discuss and investigate the pros and cons of electronic communication (i.e., email, phone, social media) versus face-to-face meetings. This is not only something that can be discussed at an interpersonal level, but also on the business side where companies must weigh the expense of travel for meetings against the impersonal electronic meetings. The interpersonal effects may be a good transition to an anti-bullying lesson/unit.

Strand	Impacts of Computing
Topic	**Social Interactions**

	CONTENT FOCUS Students should be able to evaluate how the use of computing devices can contribute or be a detriment to the economics, businesses, politics and cultural differences at the global and local levels. Students also should be able to determine how social media and technological devices can contribute to or have consequences in their daily lives. Students should be able to distinguish the benefits and ramifications of face-to-face meetings and electronic meetings. **COMPUTER SCIENCE PRACTICES** *Practice 1*. Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. 2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. *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.8.a Explain user privacy concerns related to the collection and generation of data that may not be evident through automated processes. **IC.SLE.8.b** Describe the social and economic implications of privacy in the context of safety, law or ethics to be global digital citizens.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students should have had experience with devices at school and had lessons/teacher conversations about information sharing. By the end of 8th grade, students understand and are able to explain the difference between public and personal information, the necessity of not sharing personal information and the implications of misinformation. In future grades, students should be able to apply these concepts and continually investigate security concerns and legal rights. **IMPORTANT CONCEPTS** • Identify what is considered to be personal information (e.g., address, phone number, birthdate, social security number, financial information) • Be familiar with some of the "attacks" made by third parties trying to misuse private information • Identify the consequences of providing misinformation • Review cases where auto-generated information gathering programs put the public users at risk and misused their personal data **KEY SKILL/PROCEDURES** • Differentiate between personal and public information and make decisions about which items can be safely shared within social media • Recognize third party attempts of retrieving personal information (e.g., emails, phishing) • Communicate the contents of one's digital footprint • Recognize unsafe auto-generated data collection tools • Communicate the implications of providing false or misinformation with devices **Content Elaborations** **CLARIFICATIONS** Social engineering is based on tricking people into breaking security procedures and can be thwarted by being aware of various kinds of attacks, such as emails with false information and phishing. Security attacks often start with personal information that is publicly available online. All users should be aware of the personal information, especially financial information, that is stored on the websites they use. Protecting personal online information requires authentication measures that can often make it harder for authorized users to access information. (K-12 Computer Science Framework, 2016)

Strand	Impacts of Computing
Topic	Safety, Law and Ethics
	CONTENT FOCUS Students will be able to identify and understand what information is considered to be personal (e.g., address, phone number, birthdate, social security number, financial information) vs. public. It is vital that students understand what information should be kept private and secure to protect themselves. Teachers need to reinforce that decisions made regarding their personal information will become a "digital footprint" and be at risk for "attacks" made by third parties trying to misuse private information. Students will also be able to understand how the release or sharing of personal information publicly can harm their livelihood or others. Additionally, students will learn of the long-term impact social media and auto-generated data collection tools will have on their lives because they gather and store personal information. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture *(Content Statement aligns to Core Practice rather than specific Practice Statements.)* *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.8.c Identify ethical and legal security measures used to protect electronic information.	**Expectations for Learning** **LEARNING PROGRESSION** In previous grades, students explored and identified some of the positive and negative effects technological communication has had in the business world, including the entertainment business. By the end of 8th grade, students are able to identify ways in which computing has made the demand for increased security and information protection necessary in the business world. In future grades, students will investigate security concerns, such as data breaches, privacy policies and intellectual property laws. **IMPORTANT CONCEPTS** • Be able to identify the moral and basic legal issues facing business, such as the storage of patient information by hospitals, universities and medical offices **KEY SKILL/PROCEDURES** • Explain that businesses must protect patient/client privacy and confidential information • Explain that businesses must assure the security of patient/client information **Content Elaborations** **CLARIFICATIONS** Confidential information is at risk more today than ever. Students need to have a basic understanding that they should give out their personal information to only those businesses approved by their parents. They should understand that businesses are under moral and ethical obligations to keep their sensitive data secure. **CONTENT FOCUS** Students should focus on issues that have occurred dealing with data breaches exposing personal information and the responsibilities businesses have to protect data. **COMPUTER SCIENCE PRACTICES** *Practice 1.* Fostering an Inclusive Computing Culture 1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.

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

IC.SLE.8.d Provide appropriate credit when using resources or artifacts that are not our own.	## Expectations for Learning **LEARNING PROGRESSION** In previous grades, students had some experience creating original work that may include code, text, video or graphics and had discussions on citing/providing credit to any sources that are copied/inserted into their work. By the end of 8th grade, students should continue providing credit for all sources. In future grades, students should continue providing credit for all sources. **IMPORTANT CONCEPTS** • Plagiarism/cheating is when you represent someone else's work as your own • In creating a computational artifact, students can create their own original work, including video, music, text, images, graphs and program code • When using external work to integrate into a computational artifact, one must acknowledge, attribute and/or cite sources and include a bibliography with their submission. External work that should be acknowledged includes video, music, text, images, graphs and programmed code that are used in the creation of computational artifacts **KEY SKILL/PROCEDURES** • Provide proper credit for items inserted into their work; the credit may be MLA, APA citations or some other accepted format. • Provide credit to not only textbooks, scientific reports and websites but also to appropriate persons in a collaboration effort ## Content Elaborations **CLARIFICATIONS** Ethical complications arise from the opportunities provided by computing. The ease of sending and receiving copies of media on the internet, such as video, photos and music, creates the opportunity for unauthorized use, such as online piracy, and disregard of copyrights, such as lack of attribution. (CSTA K-12 Computer Science Standards, 2017) Student need to learn the importance of providing proper credit for all the sources, not only the electronic sources but also those persons with whom they have worked.

Strand	Impacts of Computing
Topic	**Safety, Law and Ethics**
	CONTENT FOCUS Students will be able to give appropriate credit for items, such as information, videos and pictures, that they use in their work. **COMPUTER SCIENCE PRACTICES** *Practice 7.* Communicating About Computing 3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

GRADES 9-12
FOUNDATIONAL LEVEL

Strand	Computing Systems
Topic	**Devices**

CS.D.9-12.F.a Identify different multifunctional computing devices and connection technologies, both virtual and physical, to describe their purpose. **CS.D.9-12.F.b** Develop and apply criteria to evaluate computing systems for a given purpose. **CS.D.9-12.F.c** Create an artifact to demonstrate the roles and interactions of computing systems embedded in everyday objects.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will be able to identify improvements to possibly make a computing device for better interaction with users. In the 9-12 Foundational Level: Students will extract technological information about computing systems to determine effective solutions for given situations. In the 9-12 Advanced Level: Students will extract technological information about computing systems to determine and integrate the best practices for complex situations. **IMPORTANT CONCEPTS** • Different devices interact with each other • Everyday devices have computers in them • Criteria can be used to evaluate computing systems • There are multiple methods to evaluate computing systems • Computing systems can consist of both virtual and physical components **KEY SKILL/PROCEDURES** • Communicate/explain how different devices interact to determine the proper device for usage • Identify the different devices and their purpose to evaluate the proper device for usage • Create criteria to effectively evaluate a computing system • Apply a method of evaluation to verify functionality **Content Elaborations**

Strand	Computing Systems
Topic	**Devices**
	CLARIFICATIONS Examples of simple devices could be: • a garage door opened • a toaster • a microwave Examples of complex devices could be: • tablet on a refrigerator • an alarm system • a multi-functional printer Examples of virtual devices could be: • a cloud server • a remote server • a software driver emulating hardware • a virtual hard drive Examples of connecting technologies could be: • wired networks and components • routers and switches • wireless network technologies • Bluetooth **CONTENT FOCUS** Understand that everyday devices have computers Understand how different devices communicate with each other Understand the difference between virtual and physical **COMPUTER SCIENCE PRACTICES**

Strand	Computing Systems
Topic	**Devices**
	Practice 4. Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena

Strand	Computing Systems
Topic	**Hardware and Software**
CS.HS.9-12.F.a Compare and contrast interactions between application software, system software and hardware.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will make decisions on the use of hardware and software combinations to effectively complete a task. In the 9-12 Foundational Level: Students dictate the appropriate software to install onto specific hardware to work as specified. In the 9-12 Advanced Level: Students will construct a working system based on hardware and software criteria. **IMPORTANT CONCEPTS** • Hardware must have software to function • Software consists of operating systems, firmware and applications **KEY SKILL/PROCEDURES** • Evaluate the purpose of operating systems, firmware and applications to enable the hardware to operate as designed **Content Elaborations** **CLARIFICATIONS** Operating systems are software that controls the computer basic functions. Examples of operating system types are: • server (web, e-mail, file, application, print) • desktop/client • mobile • IoT • simple/complex (garage door opener/multi-function printer) Firmware controls specific hardware (graphics card). Applications provide a service for the end user.

Strand	Computing Systems
Topic	**Hardware and Software**
	CONTENT FOCUS Focus on understanding what operating systems are and how they work. **COMPUTER SCIENCE PRACTICES** *Practice 2.* Collaborating Around Computing 3. Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. 4. Evaluate and select technological tools that can be used to collaborate on a project.

Strand	Computing Systems
Topic	**Troubleshooting**
CS.T.9-12.F.a Apply a systemic process to identify problems and take steps to correct them within an integrated computing system. **CS.T.9-12.F.b** Analyze an IT device to determine either what repairs are needed or how to build it.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will be able to identify a problem, make a list of possible solutions to a problem, determine the best solution and also communicate with others to help them solve the problem. In the 9-12 Foundational Level: Students will understand the troubleshooting process to evaluate a predetermined situation. In the 9-12 Advanced Level: Students will use the troubleshooting process to resolve a real-world problem. **IMPORTANT CONCEPTS** • Systematic processes can be used to solve problems • Not all computer parts are compatible **KEY SKILL/PROCEDURES** • Apply an existing systematic process to correct problems • Identify common problems with devices • Explain the compatibility of different components **Content Elaborations** **CLARIFICATIONS** The troubleshooting process includes the following: 1. Identify a problem/gather information 2. Theorize possible solutions 3. Test possible solutions. If no solutions result, return to step 2 4. Implement the solution 5. Do a full system test. User tests system 6. Documentation **CONTENT FOCUS** Focus on using systematic processes to solve problems.

Strand	Computing Systems
Topic	**Troubleshooting**
	Understand how to analyze computer parts to identify problems. **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. *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 2. Identify and fix errors using a systematic process. *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	Networks and the Internet
Topic	**Networking**
NI.N.9-12.F.a Evaluate and select networking devices to establish scalable communications. **NI.N.9-12.F.b** Evaluate and select networking protocols to establish network communication. **NI.N.9-12.F.c** Understand scalability and reliability of networks to describe the relationships and effects of how the different types of networks work together.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will be able to develop a model representing networking hardware to understand the flow of information. Students will be able to generally identify a wide range of protocols and how they are utilized to transfer data across the internet. Students will understand that information that is lost via transmission will be retransmitted. In the 9-12 Foundational Level: Students will be able to gather information to be able to create simple LANs and WANs with the understanding of how devices connect. In the 9-12 Advanced Level: Students will be able to develop and connect a working network model from given criteria. **IMPORTANT CONCEPTS** • Network devices have connectivity • Protocols are used for network communications • Network topologies have limitations • Different network topologies can be interconnected • Devices have both a physical and logical address **KEY SKILL/PROCEDURES** • Demonstrate how to connect to a network device • Identify the tools to trace data through a network • Explain how to trace data through a network • Compare and contrast network topologies • Compare and contrast network devices • Identify the network a device is connected to • Define the common network protocols

Strand	Networks and the Internet
Topic	**Networking**

	Content Elaborations **CLARIFICATIONS** Examples of network devices could be: • hubs • switches • routers • firewalls • virtual servers This should include all versions of network addressing. The scalability and reliability of networks can be evaluated by describing the relationship between routers, switches, servers, topology and addressing. **CONTENT FOCUS** IP addresses and how they relate to devices and the network **COMPUTER SCIENCE PRACTICES** *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 2. Identify and fix errors using a systematic process.

Strand	Networks and the Internet
Topic	**Cybersecurity**
NI.C.9-12.F.a Examine and employ principles of cybersecurity. **NI.C.9-12.F.b** Identify physical, social and digital security risks to address possible attacks.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students understand physical measures to protect devices and software measures to protect electronic information. Students understand general practices used to identify malware infections. Students are able to describe how malware can affect information. In the 9-12 Foundational Level: Students will be able to understand the cybersecurity impact on business and economy. Students will be able to employ principles of cybersecurity. In the 9-12 Advanced Level: Students will be able to find the cybersecurity threat and provide a plan of action to remove the threat. **IMPORTANT CONCEPTS** • All endpoints must be protected • Physical security is the protection from physical actions and events that could cause loss or damage • Humans are the weakest point in cybersecurity **KEY SKILL/PROCEDURES** • Identify the goals, objectives and purposes of cybersecurity • Identify common risks, alerts and warning signs • Describe the concepts of malware attacks • Identify types of controls to eliminate malware from occurring • Demonstrate understanding of authentication, authorization and verification **Content Elaborations** **CLARIFICATIONS** Know a response plan to understand why it is needed Know the cybersecurity cycle to be able to create a response plan Apply authentication, authorization and verification to be able to control network usage

Strand	Networks and the Internet
Topic	**Cybersecurity**
	Know common types of cybersecurity attacks to recognize and implement counter measures Physical security is necessary in order to limit access to important hardware, making it more difficult to add malicious code to computers and network devices. Examples of physical security could include how and when to limit computer access to certain individuals, how to secure computers, and where to store backups and external hard drives. **CONTENT FOCUS** Understanding the cybersecurity cycle Response plans (i.e., plan & prepare, identify, containment, investigation, remediation, follow-up) Common types of cybersecurity attacks **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 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, taking into account key features, time and resource constraints, and user expectations. *Practice 6.* Testing and Refining Computational Artifacts 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Data and Analysis
Topic	**Data Collection and Storage**
DA.DCS.9-12.F.a Analyze patterns in a real-world data store through hypothesis, testing and use of data tools to gain insight and knowledge. **DA.DCS.9-12.F.b** Investigate data storage systems to compare and contrast how data is stored and accessed.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will consistently be able to choose and use an appropriate data tool for any given set of data. Students should be able to explain and utilize different types of file formats and explain the capacity limits of each file. Students will understand that files are stored in a root directory on the hard drive or in the cloud with folders and subfolders and be able to appropriately share files. In the 9-12 Foundational Level: Students will use scientific practices to select data analysis tools to organize data and identify trends, patterns and outliers. Students will be able to understand the benefits of different data collection tools and pick the appropriate one to use for a problem. Students will learn how data is stored on different computer systems. In the 9-12 Advanced Level: Students will apply basic techniques for locating, collecting, manipulating and interpreting small-scale multidimensional data sets (e.g., creating and distributing user surveys, accessing real-world data sets). Students will use various data collection techniques for different types of computational problems (e.g., mobile device, Global Positioning System (GPS), user surveys, embedded system sensors, open data sets, social media data sets). **IMPORTANT CONCEPTS** • Scientific practices are used for data analysis • Data collection tools can be used to find accurate data • Data analysis tools are used to interpret and investigate the data • There are different ways to represent data in a computer system that have varying costs and benefits • Data can be stored locally or on the network **KEY SKILL/PROCEDURES** • Use data analysis tools to organize data and identify trends, patterns and outliers • Use scientific practices to answer questions about real-world challenges; Gather, analyze and interpret data to develop models and explanations. • Identify an appropriate data collection tool for a given situation

Strand	Data and Analysis
Topic	Data Collection and Storage

- Demonstrate understanding of how data is stored on different computer systems

Content Elaborations

CLARIFICATIONS

Scientific practices are a methodology that focuses on investigation, evaluation and developing explanations of the natural world.

Data collection could include data found from:

- spreadsheets
- qualitative surveys
- quantitative surveys
- experimental data

Data analysis tools could include:

- filters
- pivot tables
- similarity matching
- regression
- classifications

Ways of representing data could include:

- ASCII
- UTF
- Decimal
- Binary
- Hexadecimal

Ways of encoding data could include:

- XML
- databases
- spreadsheets
- flat files

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

	CONTENT FOCUS Focus on extracting data into a data storage tool like a spreadsheet, database or XML file, and using tools to find useful information from the data Focus as well on how data and data structures can be stored on different systems. **COMPUTER SCIENCE PRACTICES** *Practice 3.* Recognizing and Defining Computational Problems 1. Identify complex, interdisciplinary, real-world problems that can be solved computationally. *Practice 4.* Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena. *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.9-12.F.a Analyze the benefits and limitations of data visualization or multisensory artifacts and tools to communicate which is most appropriate to solve a real-world problem.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will be able to take raw data and make a model from that data. Students then will be able to analyze the data in their model to determine patterns. Students will be able to utilize functions and formulas and will be able to create graphs from a spreadsheet that represent collections of data. In the 9-12 Foundational Level: Students will evaluate the ability of multisensory data artifacts to identify key features and relations by using scientific practices. In the 9-12 Advanced Level: Students will create data visualization artifacts using multiple data sources in order to analyze and answer real-world questions. **IMPORTANT CONCEPTS** • Multisensory artifacts, such as visualizations, are used to analyze data. • Different multisensory artifacts have varied benefits and limitations. • Multisensory artifacts can be used to look at real-world data and suggest solutions from the data. • Different data analysis tools, including virtual tools, have varied advantages and disadvantages. **KEY SKILL/PROCEDURES** • Explain data analyzation artifacts • Analyze multisensory data artifacts to interpret their information • Communicate complex information gathered from analysis

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

Content Elaborations

CLARIFICATIONS

A multisensory artifact could be:

- data visualizations
- audio analysis
- tactile analysis
- olfactory analysis

A data visualization artifact could be:

- a web page
- a chart
- a graph

A web page would utilize HTML and CSS to create a data visualization.

CONTENT FOCUS

Focus on creating graphs or charts to analyze a data set that are appropriate for the target audience. Present the created graphs or charts to relay the relevant information to the target audience.

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.

Practice 4. Developing and Using Abstractions

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

Practice 7. Communicating About Computing

1. Select, organize, and interpret large data sets from multiple sources to support a claim.
2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

Strand	Data and Analysis
Topic	**Inference and Modeling**
DA.IM.9-12.F.a Evaluate a model by creating a hypothesis, testing it and refining it to discover connections and trends in the data.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will be able to evaluate a model associated with a concept in order to extract meaning. In the 9-12 Foundational Level: Students will construct a model using collected data, and create a hypothesis, test it and refine it to discover connections and trends. In the 9-12 Advanced Level: Students will collect, analyze and reorganize multiple sets of data in order to construct a model, create a hypothesis, test it and refine it to discover connections and trends between the multiple sets of data. **IMPORTANT CONCEPTS** • Scientific practices should be used to analyze data in a model. • Data can be both valid or invalid. • There are many different types of data models that can be utilized. • There is proper notation to use in a simple model. **KEY SKILL/PROCEDURES** • Create a simple model from given data • Evaluate data for validity • Demonstrate an understanding of fundamental data design techniques • Identify common model notations • Evaluate the appropriateness common data model types

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

Content Elaborations

CLARIFICATIONS

Below, are steps to model data:

- Identify entity types
- Identify attributes
- Apply naming conventions
- Identify relationships
- Assign keys

Examples of data model types include hierarchical and relational.

Analyzation is to deconstruct an argument; to examine critically, so as to bring out the essential elements.

Below, are Common Model notations:

- Multiplicities (e.g., zero to one, one only, zero or more, one or more, specific range)
- Attributes (e.g., names, primary keys/unique identifier, foreign key)
- Associations (e.g., labels)

CONTENT FOCUS

The focus should be on creating a model from a set of data.

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, taking into account 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	**Algorithms**
ATP.A.9-12.F.a Define and use appropriate problem solving strategies and visual artifacts to create and refine a solution to a real-world problem. **ATP.A.9-12.F.b** Define and implement an algorithm by decomposing problem requirements from a problem statement to solve a problem.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students have a basic understanding of what goes into an algorithm and know how to write pseudocode. Students are able to analyze various solutions to determine the most efficient. Students are able to identify the parts of a program's pseudocode (input, output, decisions). In the 9-12 Foundational Level: Students will learn how to break a problem into steps, and then, in addition to pseudocode, be able to represent the algorithm using process and data flow diagrams. Students will explain the steps of the problem, and be able to communicate why they broke the problem down the way they did. Finally, they will be able to implement their created algorithm in an appropriate programming language and refine it using best practices. In the 9-12 Advanced Level: Students will progress to learn about complex list algorithms such as sorting and searching. They will also understand and explain the concept of recursion, where a method calls itself until an exit condition is met." **IMPORTANT CONCEPTS** • Algorithms are the steps to solve a problem • There are strategies that simplify problem solving • Problems can be broken down into smaller parts, such as inputs, outputs, decisions, loops and calculations • The flow of information through a program can be represented visually • Steps of a computer program can be represented by a diagram **KEY SKILL/PROCEDURES** • Demonstrate how to break a problem into steps • Create a process flow diagram, data flow diagram and pseudocode for an algorithm • Explain the steps of a problem • Implement an algorithm in an appropriate programming language • Optimize an algorithm by removing redundant or repeated code and using alternative control structures

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**

Content Elaborations

CLARIFICATIONS

Algorithms are the steps to solve a problem.

A complex problem is one in which the solution requires multiple (i.e., three or more) methods, objects and/or data structures.

Problems can be broken down into smaller parts.

Flow of information through a program can be represented visually.

Steps of a computer program can be represented by a diagram.

A problem-solving strategy has the following steps:

- Identify the problem
- Analyze the problem
- Identify decision criteria
- Develop multiple solutions
- Choose the optimal solution

CONTENT FOCUS

The most important concept is the breaking down of problems into smaller pieces. You should also focus on at least one way of visualizing the algorithm.

You should also focus on one programming language to implement the algorithm.

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.

Practice 5. Creating Computational Artifacts

2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.
3. Modify an existing artifact to improve or customize it.

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**
	Practice 6. Testing and Refining Computational Artifacts 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

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

ATP.VDR.9-12.F.a Identify types of variables and data and utilize them to create a computer program that stores data in appropriate ways.

Expectations for Learning

LEARNING PROGRESSION

By the end of grade 8:
Students will have an understanding of what it means to vary (opposed to being constant) and that this abstract value is expressed with an alphanumeric representation. Students will be able to determine the range of input values for variables. Students will be able to create, use and trace variables. Students will be able to identify a collection of information that can be represented by a single identifier.

In the 9-12 Foundational Level:
Students will understand that variables have different storage requirements and restrictions, and will be able to choose the best variable type to use for a task. Students will also use parameters to pass variable information into methods, and return values to get information out of a method. Students will also learn about scope, or when the program is able to access or change a variable.

In the 9-12 Advanced Level:
Student will move on to learn how data can be organized using different structures. This allows more complex pieces of information to be passed into and out of methods. Additionally, they will learn what the benefits and costs are for these advanced data structures. They will also see how these data structures can be used as templates to create multiple instances of the structure.

IMPORTANT CONCEPTS

- Variables are used to store data in programs
- Different types of variables store different types of data
- There are memory and performance implications for different types of variables
- Variables exist within a scope that is the block of code in which they are defined
- Variables can be used to pass data and return data to and from methods
- When primitive variables are passed to and from methods, the data is copied from one variable into another

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

KEY SKILL/PROCEDURES

- Explain the different sizes and restrictions of different data types
- Use correct data types for the storage of information
- Use parameters and return types to pass information into and out of methods

Content Elaborations

CLARIFICATIONS

A constant literal is not a variable as it cannot be changed.

Identify primitive data types (i.e., integer, Boolean, floating point)

Information should be stored in the smallest possible data type. It should also be stored in the correct data type (e.g., characters should be stored in a character data type).

Programmers create variables to store data values of selected types. A meaningful identifier is assigned to each variable to access and perform operations on the value by name. Variables enable the flexibility to represent different situations, process different sets of data, and produce varying outputs.

CONTENT FOCUS

Integer data includes integer, long integer, unsigned integer, character and byte.

Floating point includes float and double.

A string is not primitive as it is a collection of characters.

Using the correct data type allows efficiency in memory management by using just enough memory storage without overflow or underflow.

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.9-12.F.a Define control structures and Boolean logic and use them to solve real-world scenarios.

ATP.CS.9-12.F.b Use appropriate syntax to create and use a method.

ATP.CS.9-12.F.c Use data scoping to isolate data.

Expectations for Learning

LEARNING PROGRESSION

By the end of grade 8:
Students will have an understanding of variables and how to use a simple conditional and loop. Students will understand and incorporate proper processes, loops and conditionals in programs to solve problems.

In the 9-12 Foundational Level:
Students will look at Boolean statements to test a condition. They will then use this to create if/then/else statements in code. They will also code the definition of a method and then use it to solve a problem. Students will then expand their understanding to include methods that have parameters and return values. Students will also see how control structures can be nested to form more readable complex control structures.

In the 9-12 Advanced Level:
Students will move on to learn how to put together methods, control structures and data structures to form a well-written program. They will use methods to organize the code into readable parts, data structures to organize data for easier processing, and control structures to direct the flow of the program. They will also learn to identify and remove redundant and inefficient code from a program.

IMPORTANT CONCEPTS

- An IF Statement conditionally executes a section of code based on the outcome of a Boolean statement
- A Boolean statement compares one or more items using comparison and logical operators and returns true or false
- Code can be executed repeatedly using loops.
- Methods can be used to organize and allow the reuse of code
- Scope determines when and where a variable can be accessed
- Variables can be used to pass data and return data through methods
- Decimal data could be too precise to be used in Boolean statements and cannot be used in switch selection

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

KEY SKILL/PROCEDURES

- Write an IF statement to compare one or more items and execute code depending on whether it is true or false
- Apply iteration (loops) to solve a programming problem
- Use logical operators in compound conditional statements
- Code the definition of a method
- Call a method to solve a problem
- Use parameters and return types to pass information into and out of methods
- Nest same and different control structures

Content Elaborations

CLARIFICATIONS

Examples of control structures could be:

- if-else
- switch
- loops
- method definitions
- calling methods

A switch selects a section of code to execute based upon the value of a variable.

Coding a definition of a method involves writing out the all the code necessary to use it in a program.

Comparison operators evaluate the relation between two objects and return TRUE or FALSE.

Logical operators evaluate the relation between multiple statements and return TRUE or FALSE.

NOT reverses the Boolean outcome. For example, if a Boolean outcome results in TRUE, a NOT would result in comparing it to FALSE. If a Boolean outcome is FALSE, a not would result in comparing it to TRUE.

Programmers consider tradeoffs related to implementation, readability, and program performance when selecting and combining control structures.

Strand	Algorithmic Thinking and Programming
Topic	**Control Structures**
	Programs use procedures to organize code, hide implementation details, and make code easier to reuse. Procedures can be repurposed in new programs. Defining parameters for procedures can generalize behavior and increase reusability. **CONTENT FOCUS** Below, are key control structures that should be addressed (syntax and practice): • If-else • For and while loops • Method declaration • Calling methods • Comparison and logical operators Understanding program flow (defining and calling methods) is very difficult for new learners. Spend a lot of time on simple method declarations and method calls. **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 1. Extract common features from a set of interrelated processes or complex phenomena. 3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity. *Practice 5.* Creating Computational Artifacts 2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**
ATP.M.9-12.F.a Break down a solution into procedures using systematic analysis and design. Equivalent to: ATP.A.9-12.F.b Define and implement an algorithm by decomposing problem requirements from a problem statement to solve a problem. **ATP.M.9-12.F.b** Create computational artifacts by systematically organizing, manipulating and/or processing data. (Oklahoma L1.AP.M.02) Addressed in: **ATP.VDR.9-12.A.a** Utilize different data storage structures to store larger and more complex data than variables can contain. **ATP.VDR.9-12.A.b** Identify the appropriate data structures or variables to use to design a solution to a complex problem.	(See ATP.A.9-12.F.b for model curriculum information)

Strand	Algorithmic Thinking and Programming
Topic	**Program Development**
ATP.PD.9-12.F.a Investigate software development methodologies to select the appropriate one for a project to complete as a team. **ATP.PD.9-12.F.b** Compare test methodologies to evaluate why each is used and to determine their benefits and costs. **ATP.PD.9-12.F.c** Correctly use consistent naming conventions, version control and comments to demonstrate why these are important for future use, maintenance and reuse of code.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will be able to design and create their own code-based program using transitional programming languages. Students will be able to identify run-time and logical errors and modify and test code in order to make the program robust. Students will be experienced using pre-built procedures that have one or more parameters. In the 9-12 Foundational Level: Students will define different software development lifecycle methodologies, including phases, roles and work flows. Students will also see how unit, system and integration tests differ, and what they are used for. They will also see how common conventions, such as naming and commenting conventions, will improve code fixes and readability. Students will also see how source control can make finding errors easier by illustrating the changes that were made to the code. In the 9-12 Advanced Level: Students will then learn how to implement a solution to a problem using a software methodology from inception through support. This will require them to learn how to communicate as a team and work within their assigned role. Additionally, they will see how the practices they have learned so far make the project implementation simpler." **IMPORTANT CONCEPTS** • A software methodology is a series of phases to manage the design, development, testing and support of a software project • Different software methodologies have different roles and organization of team members to complete a project • Testing methodologies specifies when and how coding is tested • Consistent naming conventions, version control and comments allow for easier maintenance and reuse of code

Strand	Algorithmic Thinking and Programming
Topic	Program Development

KEY SKILL/PROCEDURES

- Define different software methodologies, including phases, roles and work flows
- Utilize unit test, system test and integration test to validate an application
- Utilize print statements, logging statements and debuggers to identify and correct issues
- Define and follow a naming and commenting convention
- Use source control to maintain versions of code
- Use appropriate standard industry language when talking about project management

Content Elaborations

CLARIFICATIONS

Software methodologies include Waterfall, Agile, top-down, bottom-up and RAD.

Version control software is software that maintains revisions and changes to code. Examples would include GIT, TFS and SVN.

People design meaningful solutions for others by defining problems, criteria and constraints, carefully considering the diverse needs and wants of the community and testing whether criteria and constraints were met.

CONTENT FOCUS

Key software methodologies are the Waterfall Model and Agile Development model. The steps in both and differences in approach should be discussed in this phase.

GIT is the most common version control structure used by colleges and students should know how to use it to save, see and merge changes to files.

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, taking into account key features, time and resource constraints, and user expectations.

Practice 6. Testing and Refining Computational Artifacts
1. Systematically test computational artifacts by considering all scenarios and using test cases.
2. Identify and fix errors using a systematic process.

Strand	Impacts of Computing
Topic	**Culture**
IC.Cu.9-12.F.a Analyze new technology to predict realistic impacts on society. **IC.Cu.9-12.F.b** Explore other professions to understand how computing has and will impact them positively and negatively.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students will have an understanding of the impact of computing on our country and the global economies. Students have identified technologies that have bias and accessibility issues for many areas of the world, persons with disabilities, and those of a lower social economic status. In the 9-12 Foundational Level: Students will analyze new technologies to be able to predict and recognize their impact on society, economy and culture. In the 9-12 Advanced Level: Students will be able to evaluate, analyze, adapt and make predictions about new technologies and professions to solve real-world situations. These real-world situations will include a wide variety of economic, scarcity, social and geopolitical factors. Students will focus on individual, local and global interactions to solve these higher level real-world situations. **IMPORTANT CONCEPTS** • Technology can have positive and negative effects on society • Technology can often have unintended effects on society • New technologies should be studied in ways that measure their impact on society • Computers have had a major impact on many professions, not only computer programming jobs • Computer science skills are important to many different professions **KEY SKILL/PROCEDURES** • Analyze technology's impact on society • Describe the different impacts technology can have on society • Explain the changes that computers have brought to other professions • Define what skills are included in computer science • Investigate what professions are now using computer science skills

Strand	Impacts of Computing
Topic	**Culture**

Content Elaborations

CLARIFICATIONS

Examples of the impacts technology has had on society often address mentality, working different hours, no longer being connected to land lines and different jobs.

Changes that computer have brought to professions would be effects such as fewer machinists and more robotics in manufacturing.

CONTENT FOCUS

Focus on how technology has changed society. Focus especially on the unintentional and unexpected consequences of technological innovation.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

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

Practice 2. Collaborating Around Computing

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

Strand	Impacts of Computing
Topic	**Social Interactions**

IC.SI.9-12.F.a Evaluate tools to increase connectivity of people in different cultures and career fields.

IC.SI.9-12.F.b Analyze the collection and generation of data through automated processes to explain the privacy concerns that are not always evident to users.

Expectations for Learning

LEARNING PROGRESSION

By the end of 8th grade:
Students will have evaluated the pros and cons of face-to-face interactions versus electronic interactions (e.g., emails, phones, social media).

In the 9-12 Foundational Level:
Students will create and use detailed criteria to evaluate the appropriateness of different computer communication tools to solve a given problem. Students will also begin to recognize and investigate the amount of information generated by a computer's automated processes and the resulting privacy concerns.

Beyond the 9-12 Foundational Level:
Students will continue to investigate digital social interactions at the collegiate level.

IMPORTANT CONCEPTS

- Technology has made communication much cheaper and easier
- Criteria can be created and used to determine the best solution to a problem
- There are many tools that can be used to increase communication, and each has different costs and benefits
- Information is valuable
- Many people do not understand when and how their information is collected and used
- Giving away private information can make it easier for your identity to be stolen

KEY SKILL/PROCEDURES

- Identify criteria that would be useful in evaluating computer communication tools
- Evaluate and use computer communication tools for appropriateness to solve a given problem
- Compare and contrast different communication tools
- Understand the value of information, especially personally identifiable information
- Describe how automated processes can capture data
- Explain the privacy concerns of automatic data collection

Strand	Impacts of Computing
Topic	**Social Interactions**

Content Elaborations

CLARIFICATIONS

Examples of computer communication tools include email, social networking sites, IM, RF and Bluetooth.

Personally identifiable information is any information that can tie a piece of data back to the person who originally owned it. Examples would include SSN, last name, first name, favorite food, birth city and state, ID number and credit card information.

Criteria for evaluating communication tools could include reliability, access to software/hardware, cost and bandwidth requirements.

CONTENT FOCUS

Focus on how technology has affected communication and the difficulty in using communication tools without giving up some privacy information. Do not worry too much about the mechanisms of automated collection. Focus on the impact of automated collection.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.
2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability.

Practice 2. Collaborating Around Computing

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

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.9-12.F.a Interpret and analyze breaches in privacy and security to investigate the legal and ethical impact. **IC.SLE.9-12.F.b** Analyze the concepts of usability and security to explain typical tradeoffs between them. **IC.SLE.9-12.F.c** Analyze the collection and generation of data through automated processes to explain the legal concerns that are not always evident to users. **IC.SLE.9-12.F.d** Explain the beneficial and harmful effects of intellectual property laws to determine the impacts on innovation.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of grade 8: Students understand and are able to explain the difference between public and personal information, the necessity of not sharing personal information and the implications of misinformation. In the 9-12 Foundational Level: Students will investigate security concerns, data breaches, privacy policies, intellectual property laws, the inverse relationship of usability versus security, a user's legal rights and the Creative Commons license. All these investigations will focus on both the legal and ethical impacts on our complex society. In the 9-12 Advanced Level: Students will further investigate the inverse relationship of usability versus security as well as all aspects of copyright law. This will also include creating, solving and implementing solutions to a variety of real-world situations. **IMPORTANT CONCEPTS** • There are legal ramifications when individuals or groups break security or privacy laws • There are many practices involving privacy and security that, while technically legal, are not ethical • It is difficult to increase security in a system without decreasing usability • It is difficult to increase usability in a system without decreasing security • Automated collection of data can have legal implications depending on how it is done • Users have legal rights that they often are not aware of • Intellectual property laws impact how data can be used and what attribution is required • There are multiple types of licenses that can be applied to information and processes • Intellectual property laws can both protect creators and stifle innovation • Software "Terms of Use" and privacy policies can affect your legal rights

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

KEY SKILL/PROCEDURES

- Describe what constitutes a breach of security or a breach of privacy
- Analyze security and privacy breaches
- Summarize the legal and ethical impact of security breaches
- Explain the difference between law and ethics
- Analyze the tradeoffs between security and usability
- Describe the legal protections people have under current laws
- Compare how different companies use automatic processes of data collection
- Define intellectual property
- Explain the beneficial and harmful effects of intellectual property laws
- Describe the different types of licenses that exist to protect content creators
- Explain what a Creative Commons license is and how it is used

Content Elaborations

CLARIFICATIONS

Analyzing security and privacy breaches could include looking at how they happened and why. Additionally, you could examine what the company could have done to minimize or avoid the breach.

Students should understand software "Terms of Use" and privacy policies.

Your legal rights include the rights to your personal data and your intellectual property rights.

CONTENT FOCUS

Focus on tradeoffs, both security versus usability and free software versus commercial software. You do not need to go deeply into legal understanding. A basic understanding should be sufficient to discuss the impact of the laws.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating About Computing

1. Select, organize, and interpret large data sets from multiple sources to support a claim.
2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.
3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

ADVANCED LEVEL

Strand	Computing Systems
Topic	**Devices**
CS.D.9-12.A.a Evaluate the function of various devices to formulate a human interaction solution. **CS.D.9-12.A.b** Integrate multifunctional computing devices to solve a problem. **CS.D.9-12.A.c** Identify the functionality of various categories of hardware components and the communication between them, and use that information to build a system virtually or physically for a specific task.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of the 9-12 Foundational Level: Students will be able to extract technological information about computing systems to determine the best practice for situations. In the 9-12 Advanced Level: Students will extract technological information about computing systems to determine and integrate the best practices for complex situations. Beyond High School: Students will gain a deeper understanding of how all devices interact in computing systems at the collegiate level. **IMPORTANT CONCEPTS** • Devices are used to solve problems • Different devices interact with multiple devices • Different devices can be connected into a computing system • There are multiple methods to evaluate a computing system **KEY SKILL/PROCEDURES** • Differentiate between a simple and complex device to understand how each is used both independently and as a resource in a system • Utilize multifunctional computing devices to solve a problem • Build a computing system to solve a need

Strand	Computing Systems
Topic	**Devices**

	Content Elaborations **CLARIFICATIONS** Examples of simple devices could be – • a garage door opener • a toaster • a microwave Examples of complex devices could be – • a tablet on a refrigerator • alarm system • multi-functional printer **CONTENT FOCUS** Understand how multiple devices communicate with each other Utilize multiple devices to solve a problem **COMPUTER SCIENCE PRACTICES** *Practice 4.* Developing and Using Abstractions 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	Computing Systems
Topic	**Hardware/Software**
CS.HS.9-12.A.a Categorize types of operating systems and how they will be used.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of the 9-12 Foundational Level: Students are able to dictate the appropriate software to install onto specific hardware to work as specified. In the 9-12 Advanced Level: Students will construct a working system based on hardware and software criteria. Beyond High School: Students will continue to further explore and evaluate the interactions and relationships between systems software and hardware at the collegiate level. **IMPORTANT CONCEPTS** • Different operating systems are used for different purposes **KEY SKILL/PROCEDURES** • Describe the hardware requirements and the purpose of the hardware to determine which operating system will be used for installation **Content Elaborations** **CLARIFICATIONS** Operating systems are software that controls the computer basic functions. Examples of operating system types are: • server (web, e-mail, file, application, print) • desktop/client • mobile • IoTsimple/complex (garage door opener/multi-function printer) **CONTENT FOCUS** Focus on constructing a system for a given purpose.

Strand	Computing Systems
Topic	**Hardware/Software**
	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, taking into account 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. 3. Modify an existing artifact to improve or customize it. *Practice 6.* Testing and Refining Computational Artifacts 6.3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Computing Systems
Topic	**Troubleshooting**
CS.T.9-12.A.a Evaluate and revise a systematic process to identify the source of a problem and the steps to correct it within individual and connected devices.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of the 9-12 Foundational Level: Students will understand the troubleshooting process to evaluate a predetermined situation. In the 9-12 Advanced Level: Students will use the troubleshooting process to resolve a real-world problem. Beyond High School: Students will continue to identify and compare more complex problems in computing systems at the collegiate level. **IMPORTANT CONCEPTS** • Some processes are better suited to troubleshoot a given problem • Processes can be fine-tuned to create a better solution **KEY SKILL/PROCEDURES** • Evaluate a systematic process for suitability to a problem • Modify a systematic troubleshooting process **Content Elaborations** **CLARIFICATIONS** The troubleshooting process includes the following: 1. Identify a problem/Gather information. 2. Theorize possible solutions. 3. Test possible solutions. If no solutions result, return to step 2. 4. Implement the solution. 5. Do a full system test. User tests system. 6. Documentation **CONTENT FOCUS** Focus on identifying the most effective systematic process to solve a problem.

Strand	Computing Systems
Topic	**Troubleshooting**
	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. *Practice 6*. Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 2. Identify and fix errors using a systematic process. *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	Networks and the Internet
Topic	**Networking**

NI.N.9-12.A.a Construct a networking devices map solution for a real-world scenario to establish communication between distant devices. **NI.N.9-12.A.b** Develop a solution to a real-world scenario using networking protocols to establish network communication. **NI.N.9-12.A.c** Improve scalability and reliability of networks to describe the relationships and effects of how the different types of networks work together.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of the 9-12 Foundational Level: Students are able to gather information to be able to create simple LANs and WANs with the understanding of how devices connect. In the 9-12 Advanced Level: Students will be able to develop and connect a working network model from given criteria. Beyond High School: Students should be able to fully understand how devices communicate and connect beyond the local LAN. **IMPORTANT CONCEPTS** • Network architecture is both logical and physical subnetting • Protocols are used for network communications **KEY SKILL/PROCEDURES** • Demonstrate understanding of subnetting • Choose the appropriate network protocol to use for specific communication situations • Create a LAN • Expand a LAN to a WAN **Content Elaborations** **CLARIFICATIONS** Know IPV4 and IPV6 addressing Know variable length subnetting and CIDR notation Know basic networking protocols Distance communication can be a remote connection/VPN connection.

Strand	Networks and the Internet
Topic	**Networking**
	CONTENT FOCUS IPV4 and IPV6 addressing Variable length subnetting and CIDR notation Basic networking protocols **COMPUTER SCIENCE PRACTICES** *Practice 2.* Collaborating Around Computing 4. Evaluate and select technological tools that can be used to collaborate on a project. *Practice 4.* Developing and Using Abstractions 2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures. 3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity. *Practice 5*. Creating Computational Artifacts 3. Modify an existing artifact to improve or customize it.

Strand	Networks and the Internet
Topic	**Cybersecurity**
NI.C.9-12.A.a Identify cybersecurity ethics and law. **NI.C.9-12.A.b** Implement a devised solution to counter a security threat.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of the 9-12 Foundational Level: Students are able to understand the cybersecurity impact on business and economy. In the 9-12 Advanced Level: Students will be able to find the cybersecurity threat and provide a plan of action to remove the threat. Beyond High School: Students will be able to intern at a company and be able to help identify and mitigate cybersecurity threats in real time. **IMPORTANT CONCEPTS** • There is a difference between ethical and unethical uses of cybersecurity • There are multiple techniques that can be used to counter a security threat • A plan of action should include multiple ways to secure a network and counter an attack **KEY SKILL/PROCEDURES** • Remove malware threats • Implement authentication, authorization and verification • Implement a plan of action to remove a cybersecurity threat **Content Elaborations** **CLARIFICATIONS** Know what virus protection software does and how it works Understand a signature to be able to maintain integrity Know how to detect where threats are located and how to remove these safely (i.e., safe mode) Know how to reinstall the system from backups Know how social threats are used to alter reliability (e.g., changing of data)

Strand	Networks and the Internet
Topic	**Cybersecurity**
	CONTENT FOCUS Understanding virus protection Focus on ethics and laws regarding cybersecurity Implementing a solution to address threats **COMPUTER SCIENCE PRACTICES** *Practice 2.* Collaborating Around Computing 1. Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities. 4. Evaluate and select technological tools that can be used to collaborate on a project. *Practice 3.* Recognizing and Defining Computational Problems 2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.

Strand	Data and Analysis
Topic	**Data Collection and Storage**
DA.DCS.9-12.A.a Create multidimensional data collections that can be utilized through various methods to solve complex data problems. **DA.DCS.9-12.A.b** Investigate data storage and collection tools to analyze tradeoffs and limitations.	**Expectations for Learning** **LEARNING PROGRESSION** In the 9-12 Foundational Level: Students will use data analysis tools and scientific practices to organize data and identify trends, patterns and outliers. Students will be able to understand the benefits of different data collection tools and pick the appropriate one to use for a problem. Students will learn how data is stored on different computer systems. By the end of the 9-12 Advanced Level: Students will apply basic techniques for collecting, manipulating and interpreting small-scale multidimensional data sets (e.g., collecting and organizing user surveys, accessing real-world data sets). Students will use various data collection techniques for different types of computational problems (e.g., mobile device Global Positioning System (GPS), user surveys, embedded system sensors, open data sets, social media data sets). Beyond High School: Students will apply techniques for collecting, manipulating and interpreting large-scale multidimensional data sets (e.g., collecting and organizing user surveys, accessing real-world data sets). **IMPORTANT CONCEPTS** • A multidimensional collection is a collection of multiple sets of the same data • Multidimensional collections can vary in performance depending on the data **KEY SKILL/PROCEDURES** • Utilize various methods of data collection • Manipulate and interpret small-scale multidimensional data sets • Identify the best data collection tool for a given situation

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

Content Elaborations

CLARIFICATIONS

When collecting data, be sure to address tradeoffs and limitations of data storage.

Below, are examples of multidimensional collections:

- A library contains data about books.
- A window has many panes.
- A video game has many NPCs who have the same attributes, but different values in those attributes.

Data analysis tools could include:

- Spreadsheets
- Charts
- Graphs
- SQL

CONTENT FOCUS

Focus on how to collect, organize and manipulate data to solve real-world problems.

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.9-12.A.a Create visualization or multisensory artifacts to communicate insights and knowledge gained from complex data analysis that answers real-world questions.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of the 9-12 Foundational Level: Students will be able to evaluate the ability of data visualization artifacts to identify key features and relations by using scientific practices. In the 9-12 Advanced Level: Students will, given a real-world relatable problem, perform complex data analysis to create a data visualization that produces an optimal solution. Beyond High School: Students will further their understanding of advanced visualization techniques. They will also look at advanced data analysis tools. **IMPORTANT CONCEPTS** • Data analysis is used to find pattern and trends • Different inputs and actions can affect behaviors • Real-world questions can be restated and interpreted as data questions • Based on the data analysis, changes can be made to improve a solution or process **KEY SKILL/PROCEDURES** • Accurately complete complex data analysis • Create multisensory artifacts from data sets • Translate real-world questions into data analysis questions • Communicate the solutions found in the data set

Strand	Data and Analysis
Topic	Visualization and Communications

Content Elaborations

CLARIFICATIONS

Complex data analysis could include:

- relational database queries
- data regression
- spreadsheets
- inferences
- predictions

Data questions include testable hypotheses based on the data. For example, "If the price of eggs goes up, do people buy fewer eggs?"

CONTENT FOCUS

Focus on how to translate real-world questions into data questions that can be answered by data analysis. Have students create and present the visualizations based on their analysis.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems
1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.

Practice 5. Creating Computational Artifacts
2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.

Practice 7. Communicating About Computing
1. Select, organize, and interpret large data sets from multiple sources to support a claim.
2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.

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

DA.IM.9-12.A.a Create a model that simulates a complex system and uses extracted data to hypothesize, test and refine the model to discover connections or trends.

Expectations for Learning

LEARNING PROGRESSION

In the 9-12 Foundational Level:
Students will construct a model using collected data, and create a hypothesis, test it and refine it to discover connections and trends.

In the 9-12 Advanced Level:
Students will collect, analyze and reorganize multiple sets of data in order to construct a model, and create a hypothesis, test it and refine it to discover connections and trends between the multiple sets of data.

Beyond High School:
Student will collect, analyze and reorganize multiple sets of data to construct a real-world model to find patterns and be able to do prediction analysis.

IMPORTANT CONCEPTS

- Data models can have different applications
- Data models can be constructed from multiple data sources

KEY SKILL/PROCEDURES

- Demonstrate an understanding of when and when not to create a data model
- Explain and correctly use advanced common model notations
- Create a data model from multiple data sources

Content Elaborations

CLARIFICATIONS

Apply data model patterns

Normalize to reduce data redundancy

Denormalize to improve performance

An example of multiple sets of data would be a high school course registration where the following exists: a schedule, prerequisites, seat maximum/minimum, teacher/course availability and early registration for more senior students.

Strand	Data and Analysis
Topic	**Inference and Modeling**
	Below, are common model notations: • Associations • Entity roles • Subtyping • Aggregation • Composition • OR constraint • Exclusive OR (XOR) constraint **CONTENT FOCUS** Use advanced common model notations when creating a data model from multiple sources. **COMPUTER SCIENCE PRACTICES** *Practice 6.* Testing and Refining Computational Artifacts 1. Systematically test computational artifacts by considering all scenarios and using test cases. 2. Identify and fix errors using a systematic process. 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility. *Practice 7.* Communicating About Computing 3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**

ATP.A.9-12.A.a Define and explain recursive algorithms to understand how and when to apply them.

ATP.A.9-12.A.b Use recursion to effectively solve problems.

ATP.A.9-12.A.c Define and explain sorting and searching algorithms to understand how and when to apply them.

ATP.A.9-12.A.d Use sorting and searching to analyze and organize data.

Expectations for Learning

LEARNING PROGRESSION

By the end of the 9-12 Foundational Level:
Students can break a problem into steps, and then, in addition to pseudocode, represent the algorithm using process and data flow diagrams. Students can explain the steps of the problem, and be able to communicate why they broke the problem down the way they did. Finally, they can implement their created algorithm in an appropriate programming language and refine it using best practices.

In the 9-12 Advanced Level:
Students will use complex list algorithms such as sorting and searching. They will also understand, explain and use the concept of recursion, where a method calls itself until an exit condition is met.

Beyond High School:
Students will look at how to describe the efficiency of algorithms to better compare them. Additionally, they will learn how advanced algorithms are crafted for tasks such as artificial intelligence and pathing.

IMPORTANT CONCEPTS

- A recursive method must simplify a problem and have an exit condition
- Sorting and searching analyzes and organizes data
- Different sorting and searching algorithms work more efficiently with different sets of data

KEY SKILL/PROCEDURES

- Describe how recursive algorithms can be more or less effective than iterative algorithms
- Demonstrate how to rewrite simple algorithms from iterative to recursive
- Explain Recursive Sorting algorithms
- Explain Simple Sorting algorithms
- Explain simple and binary searches

Content Elaborations

CLARIFICATIONS

Use a visualization to show the various searches, efficiency of access times and completion times.

Demonstrate the construction and logic behind a decimal to binary recursive function.

Strand	Algorithmic Thinking and Programming
Topic	**Algorithms**
	A simple sort does not utilize recursion. **CONTENT FOCUS** Focus on using already optimized algorithms for determining which should be used. Recursion should be understood and utilized, not necessarily created from scratch. **COMPUTER SCIENCE PRACTICES** *Practice 4*. Developing and Using Abstractions 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. *Practice 5*. Creating Computational Artifacts 2. Create a computational artifact for practical intent, personal expression, or to address a societal issue. *Practice 6.* Testing and Refining Computational Artifacts 3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Algorithmic Thinking and Programming
Topic	**Variables and Data Representation**
ATP.VDR.9-12.A.a Utilize different data storage structures to store larger and more complex data than variables can contain. **ATP.VDR.9-12.A.b** Identify the appropriate data structures or variables to use to design a solution to a complex problem.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of the 9-12 Foundational Level: Students will understand that variables have different storage requirements and restrictions, and will be able to choose the correct variable type to use for a task. Students will be able to use parameters to pass variable information into methods and return values to get information out of a method. Students will understand scope or when the program is able to access or change a variable. In the 9-12 Advanced Level: Student will learn how data can be organized using different structures. Students will learn that this allows more complex pieces of information to be passed into and out of methods. Additionally, they will learn what the benefits and costs are for these advanced data structures. They will also see how these data structures can be used as templates to create multiple instances of the structure. Beyond High School: Students will continue to learn how to store larger and more complex pieces of data. They will also investigate connecting to larger data stores like databases and how to store information from a database in a local data structure. **IMPORTANT CONCEPTS** • Data structures can be used to represent multiple variables as one item • Advanced data types are more appropriate for certain problems • Multiple similar pieces of data can be stored in a structure called an array • Variables and data structures can be passed into a method by reference or by value **KEY SKILL/PROCEDURES** • Code the definition of a data structure and implement multiple instances • Use a data structure to pass information into or out of a method • Describe the benefits and costs of advanced data structures • Demonstrate how data structures can be passed to and from methods and objects • Organize like data into an array

Strand	Algorithmic Thinking and Programming
Topic	Variables and Data Representation

Content Elaborations

CLARIFICATIONS

Data structures could include classes, json objects, stucts, records and xml.

Coding a definition of a data structure involves writing out all of the code necessary to use it in a program.

An example of implementations would be objects created from a data structure.

Data structures are used to manage program complexity. Programmers choose data structures based on functionality, storage and performance tradeoffs.

Passing a variable by reference points to its original memory location, and changes in the method will be reflected in the passed variable.

Passing a variable by value will create a temporary local variable that can be changed without changing the passed variable.

Not all languages support choose pass by value or pass by reference. In many languages, this may be automatically determined based on data type.

CONTENT FOCUS

Strings are basically 1D arrays. A typical data table is an example of a 2D array.

A list is similar to an array, but elements are ordered in some manner, and can be added and removed, varying the size of the list.

The language being studied may dictate the data structures being used.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

1. Extract common features from a set of interrelated processes or complex phenomena.
3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.

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

ATP.CS.9-12.A.a Write programs that use library methods and control structures and methods to solve a problem.

ATP.CS.9-12.A.b Refactor a program to be smaller and more efficient.

Expectations for Learning

LEARNING PROGRESSION

By the end of the 9-12 Foundational Level:
Students will understand how to use both binary and unary Boolean statements to test a condition. They can use this to create if/then/else statements in code. They can also code the definition of a method and then use it to solve a problem. Students will understand how to create methods that have parameters and return values. Students know how control structures can be nested to form more readable complex control structures.

In the 9-12 Advanced Level:
Students will learn how to put together methods, control structures and data structures to form a well-written program. They will use methods to organize the code into readable parts, data structures to organize data for easier processing, and control structures to direct the flow of the program. They will also learn to identify and remove redundant and inefficient code from a program.

Beyond High School:
Students will expand their knowledge of methods and control structures by seeing how multiple programming languages handle them. They will also look at how programming languages turn these control structures into machine code.

IMPORTANT CONCEPTS

- Developers can use code from other sources to complete their programs
- Code that appears in multiple places in a program can be put into a method for code reuse
- Programs are made up of methods, control structures and data structures working together

KEY SKILL/PROCEDURES

- Create and call multiple methods in a program
- Write a program to solve a problem using methods, control structures and data structures
- Identify and remove redundant and inefficient code from a program

Strand	Algorithmic Thinking and Programming
Topic	Control Structures

Content Elaborations

CLARIFICATIONS

Refactoring a program involves rewriting modules to make them more efficient by simplifying algorithms, removing inefficient code and using optimal control structures.

Complex programs are designed as systems of interacting modules, each with a specific role, coordinating for a common overall purpose. These modules can be procedures within a program; combinations of data and procedures; or independent, but interrelated, programs. Modules allow for better management of complex tasks.

CONTENT FOCUS

Key library methods include:

- math related functions (square root, sin, cos)
- input and output functions such as reading and writing to and from the console and files

Optional 3rd party libraries include graphical user interface tools.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions
2. Evaluate existing technological functionalities and incorporate them into new designs.

Practice 5. Creating Computational Artifacts
2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.

Practice 6. Testing and Refining Computational Artifacts
3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability, and accessibility.

Strand	Algorithmic Thinking and Programming
Topic	**Modularity**
ATP.M.9-12.A.a Construct solutions to problems using student-created components (e.g., procedures, modules, objects). Equivalent to: ATP.CS.9-12.F.b Use appropriate syntax to create and use a method. **ATP.M.9-12.A.b** Design or redesign a solution to a large-scale computational problem by identifying generalizable patterns. Equivalent to: ATP.PD.9-12.A.a Fully implement the most appropriate software methodology to complete a team programming project. **ATP.M.9-12.A.c** Create programming solutions by reusing existing code (e.g., libraries, Application Programming Interface (APIs), code repositories). Equivalent to: ATP.CS.9-12.A.a Write programs that use library functions, methods and control structures to solve a problem.	(**For ATP.M.9-12.A.a**: See ATP.CS.9-12.F.b for model curriculum information) (**For ATP.M.9-12.A.b**: See ATP.PD.9-12.A.a for model curriculum information) (**For ATP.M.9-12.A.c**: See ATP.CS.9-12.A.a for model curriculum information)

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

ATP.PD.9-12.A.a Fully implement the most appropriate software methodology to complete a team programming project.

Expectations for Learning

LEARNING PROGRESSION

By the end of the 9-12 Foundational Level:
Students will be able to define different software development lifecycle methodologies, including phases, roles and work flows. Students will understand how unit, system and integration tests differ and what they are used for. They will also understand how common conventions, such as naming and commenting conventions, improve code fixes and readability. Students will also understand how source control can make finding errors easier by illustrating the changes that were made to the code.

In the 9-12 Advanced Level:
Students will learn how to implement a solution to a problem using a software methodology from inception through support. This will require them to learn how to communicate as a team and work within their assigned role. Additionally, they will see how the practices they have learned so far make the project implementation simpler.

Beyond High School:
Students will further their understanding by seeing how larger groups can operate effectively. They will see how multiple team projects can work to get complex tasks done very quickly. They will also understand some of the pitfalls and difficulties large scale projects hold, including legacy code, communication and data storage.

IMPORTANT CONCEPTS

- Software development lifecycle methodologies allow a team to work more efficiently
- Software development lifecycle methodologies outline the steps for design, development, test, rollout and support for an application, and the roles of team members
- Two or more programmers may be working on the same program at the same time, but on different sections. Defining coding standards and updating design documentation helps integrate the different methods each programmer is implementing

KEY SKILL/PROCEDURES

- Solve a complex problem as a team using a single software methodology
- Gather requirements from stakeholders
- Collaborate with team members

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

Content Elaborations

CLARIFICATIONS

Software methodologies include Waterfall, Agile, top-down, bottom-up and RAD.

Diverse teams can develop programs with a broad impact through careful review and by drawing on the strengths of members in different roles. Design decisions often involve tradeoffs. The development of complex programs is aided by resources such as libraries and tools to edit and manage parts of the program. Systematic analysis is critical for identifying the effects of lingering bugs.

Collaboration involves:

- a shared communication medium
- a common vision of the end product
- regularly scheduled meetings
- a clear understanding of roles

A stakeholder is a person with an interest or concern in the project.

CONTENT FOCUS

The focus here is to use a software methodology from beginning to end, enabling students to see the methodology in action. The students should see how specific jobs within the methodology support one another.

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, taking into account key features, time and resource constraints, and user expectations.

Practice 6. Testing and Refining Computational Artifacts

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

Strand	Impacts of Computing
Topic	**Culture**

IC.Cu.9-12.A.a Evaluate an alternative solution where a current tool does not exist due to limited resources. **IC.Cu.9-12.A.b** Analyze the equity, access and influence of the distribution of computing resources to see their global impact. **IC.Cu.9-12.A.c** Design a study to predict how computers will revolutionize an aspect of our culture.	**Expectations for Learning** **LEARNING PROGRESSION** By the end of the 9-12 Foundational Level: Students practiced analyzing new technologies and professions, using appropriate criteria to be able to predict and recognize the true measurable impact on each part of our complex society. In the 9-12 Advanced Level: Students will be able to evaluate, analyze, adapt and make predictions about new technologies and professions to solve real-world situations. These real-world situations will include a wide variety of economic, scarcity, social and geopolitical factors. Students will focus on individual, local and global interactions to solve these higher level real-world situations. Beyond High School: Students will continue to investigate the impacts of technology and computing resources on all aspects of our society and culture at the collegiate level. **IMPORTANT CONCEPTS** • Technology is not equally used or available around the world • There are often free and different alternatives to modern computing tools • It is important to account for scarcity when evaluating tools to solve a problem • Economic, social and geopolitical factors have influenced the computer's impact on the world • Computers have had a dramatic impact on our culture **KEY SKILL/PROCEDURES** • Evaluate a current computing tool's appropriateness for a specific problem • Compare and contrast computing tools based on appropriateness and scarcity • Describe some of the difficulties in distributing computing resources around the world • Explain how economic, social and geopolitical factors influence computing • Identify ways computation has revolutionized our culture • Predict how computers may impact our culture in the future

Strand	Impacts of Computing
Topic	**Culture**

Content Elaborations

CLARIFICATIONS

Computer distribution differs by network availability, such as whether broadband is available, as well as hardware availability such as the number of households that have computers.

An example of an alternative solution would be a person who does not have international phone service, but wants to talk with people from home, using a free phone app to make an online video call when both ends are connected to wifi.

CONTENT FOCUS

Focus on how computer distribution is different across the world, and how people then need to solve computing problems differently depending on their available resources.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

1. Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products.
2. Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability.

Practice 2. Collaborating Around Computing

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

Practice 7. Communicating About Computing

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

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

IC.SLE.9-12.A.a Create a scenario to demonstrate typical tradeoffs between usability and security and recommend security measures based on these or other tradeoffs.

IC.SLE.9-12.A.b Investigate intellectual property laws, including copyright, trademarks and patents, to identify some of the practical, business and ethical impacts.

Expectations for Learning

LEARNING PROGRESSION

By the end of the 9-12 Foundational Level:
Students investigated security concerns, data breaches, privacy policies, intellectual property laws, the inverse relationship of usability versus security, a user's legal rights and the Creative Commons license. All these investigations focused on both the legal and ethical impacts on our complex society.

In the 9-12 Advanced Level:
Students will further investigate the inverse relationship of usability versus security as well as all aspects of intellectual property laws. This will also include creating, solving and implementing solutions to a variety of real-world situations.

Beyond High School:
Students will continue to investigate the safety, law and ethics of digital interactions and data at the collegiate level.

IMPORTANT CONCEPTS

- Security measures must account for usability concerns to be successful
- Security requires tradeoffs, both of usability and of other concepts, such as speed, size
- Intellectual property laws include copyright, patent and trademark
- Intellectual property laws have significant impact in the computing world
- Intellectual property laws have ethical and legal implications for businesses, people, and society

KEY SKILL/PROCEDURES

- Create a realistic scenario that requires computer security
- Explain what security tradeoffs are and how they work
- Defend the tradeoffs of security and other concepts the student use
- Define copyright and explain how it is protected
- Explain what "free," "open-source" and "commercial" software types are and the differences between them
- Argue the positive and negative impacts of copyrights
- Describe how to research for existing intellectual property holdings

Strand	Impacts of Computing
Topic	Safety, Law and Ethics

Content Elaborations

CLARIFICATIONS

Any time personally identifiable information is being shared on a computer there should be security involved, so any scenario that the students create that includes this would be acceptable.

CONTENT FOCUS

Focus on using the understanding of security and usability tradeoffs to solve a problem.

COMPUTER SCIENCE PRACTICES

Practice 7. Communicating About Computing

1. Select, organize, and interpret large data sets from multiple sources to support a claim.
2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.
3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

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