Ohio’s Model Curriculum for Computer Science

Grade 8

ADOPTED SEPT. 2022

Ohio | Department of Education

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 can 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 a 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 can identify and evaluate problems, determine the best solution and 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.

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, students developed a basic understanding of how devices and protocols are used in networking. By the end of 8th grade, students can 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 a 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.

Practice 4. Developing and Using Abstractions

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

Strand	Networks and the Internet
Topic	**Networking**
	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.
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 a 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 like 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 computers. 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	Networks and the Internet
Topic	**Cybersecurity**

NI.C.8.c Compare and contrast examples of various threat actors, such as nation-states, cyberterrorist groups, organized crime or hacktivists.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students developed a general understanding that private information should be protected from malware threats, online services and unauthorized access. By the end of grade 8, students should recognize different threat actors and threat vectors that are commonly employed.

In future grades, students will be able to infer, articulate and employ best practices for threat mitigation.

IMPORTANT CONCEPTS

- There are different types of threat actors that operate differently with different motivations.
- There are different threat vectors commonly employed to access information or disrupt services.

KEY SKILLS/PROCEDURES

- Identify the types of threat actors and their objectives.
- Identify common threat vectors.
- Discuss cyber hygiene and threat mitigation.

Content Elaborations

CLARIFICATIONS

Students will begin to work more independently. Previously, they will and have been working with computing, data systems, and devices like Raspberry Pi's, Arduinos and other devices. Now students should become more aware of online threats and threat actors.

CONTENT FOCUS

Understand and discuss different threat vectors that are used by the different threat actors and their motives.

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.d Explore and differentiate examples of complex encryption methods, e.g., Vigenère, Bacon's cipher and Enigma.

Expectations for Learning

LEARNING PROGRESSION

In previous grades, students developed a general understanding of basic encryption. By the end of grade 8, students should recognize different encryption methods. In future grades, students will be able to utilize various encryption techniques to protect data.

IMPORTANT CONCEPTS

- Encryption is a key concept in password and personal data security.
- Encryption is needed to protect data in transit and at rest.
- Understanding encryption could lead students to more advanced cyber security topics.

KEY SKILLS/PROCEDURES

- Identify the goals of encryption.
- Identify types and explain the uses of encryption.
- Discuss the uses of encryption.
- Use encryption methods to solve problems.

Content Elaborations

CLARIFICATIONS

There are many classic examples of encryption that can be engaging and interesting to both teachers and students. Discuss how encryption can solve problems in computing and protect assets.

CONTENT FOCUS

As students leave grade 8, they should know and understand what personal data is, why it is important to them and why it is important to protect personally identifiable information.

Students should also understand that information and data can be protected using encryption methods and other processes. This includes the idea of the CIA triad, a concept that focuses on the balance between the confidentiality, integrity and availability of data under the protection of your information security program.

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	**Internet of Things**

NI.IOT.8.a Explore career pathways related to IoT to identify careers associated with the computer science field.

NI.IOT.8.b Model the lifecycle of information in the IoT: data gathering, transmission, reception, and analysis to recreate a real-world scenario.

Expectations for Learning

LEARNING PROGRESSION

In grade 7, students will recognize the positive and negative impacts that technology has on their daily lives, as well as the impact of technology on society as a whole. In grade 8, students will explore their career interests through embedded activities. Career exploration strategies are opportunities for students to discover and understand the various aspects of IoT importance. In grades 9-12, students can gather information so they can design simple smart applications and an accompanying life cycle.

IMPORTANT CONCEPTS

- Various careers are associated with IoT.
- IoT information has a lifecycle.

KEY SKILLS/PROCEDURES

- List the various career pathways associated with the IoT field.
- Explain the lifecycle of the information in the IoT.

Content Elaborations

CLARIFICATIONS

Students will explore IoT careers and investigate the necessary pathways to engage in future academic and industry professions.

The lifecycle of information in the IoT is data gathering, transmission, reception and analysis. To understand IoT, analysis involves recreating a real-world scenario such as using IoT-enabled lighting settings to make lights bright or dim, warm or cool.

CONTENT FOCUS

The Internet of Things (IoT) is revolutionizing every industry, from home appliances to agriculture to space exploration.

The IoT is the worldwide network of internet-connected, automated devices that sense and collect interconnected data to enable users to monitor and control an environment.

Strand	Networks and the Internet
Topic	**Internet of Things**
	COMPUTER SCIENCE PRACTICES *Practice 4.* Developing and Using Abstractions 2. Evaluate existing technological functionalities and incorporate them into new designs. *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.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 the 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 can 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 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 can collect data using • spreadsheets, • qualitative surveys, • quantitative surveys and • 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 use 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 the pathname of the 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 can 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 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 and 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 can use functions and formulas and/to create graphs from a spreadsheet that represents 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 to conclude.

Content Elaborations

CLARIFICATIONS

Students will use formulas and functions in a spreadsheet with self-collected data 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 can 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 and 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.
- Recognize and define iteration.

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 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. At this level, the expectation is that looping is done utilizing iteration, not recursion.

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 for each of their pseudocode solutions, using proper symbols for inputs, outputs and decisions.

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 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 (as 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 the scope or when the program can access or change a variable.

IMPORTANT CONCEPTS

- Identify the 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, a blank variable 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.
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 can 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 can 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 the scope, or when the program can 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 defining value(s). **CONTENT FOCUS** Students will understand that one identifier can "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 can 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 the scope and how a program can 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 allow 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, 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 loop (e.g., Input an integer and if it is even, prints 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, considering 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, 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 can 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, a 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 a 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 drawing 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)

CONTENT FOCUS

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

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. 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 can design and create their 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 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 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, considering key features, time and resource constraints and user expectations.
2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.

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

ATP.PD.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 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.

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

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	Artificial Intelligence
Topic	**Machine Learning**

AI.NI.8.a Create a program, individually and collaboratively, that implements a language processing algorithm to create a functional chatbot.

Expectations for Learning

LEARNING PROGRESSION

In grade 7, students modeled how unsupervised learning finds patterns in unlabeled data to identify how machine learning takes place. In high school, students will explain at least one way bias can enter the machine learning system and explain how that bias impacts people.

IMPORTANT CONCEPTS

- Explain the difference between a classification and a prediction model.
- Compare how the same tabular data set creates different results when run through a classification model vs. a prediction model.
- Interpret the quality of the data set once the model has been run and explain what qualities should be present.
- Describe strategies for improving data sets.

KEY SKILLS/PROCEDURES

- Students will be able to explain the difference between a classification and prediction model and the reasons for using one versus the other in machine learning.
- Students will be able to identify the quality of their data set based on the outcome of running their chosen model.
- Students will be able to train a classification model or prediction model using a tabular data set.

Content Elaborations

CLARIFICATIONS

A classification model is a process of finding a good model that describes the data classes or concepts. The purpose of classification is to predict the class of objects whose class label is unknown. A prediction model identifies or predicts the missing or unavailable data for a new observation based on the previous data and future assumptions. In prediction, the output is a continuous value. A tabular data set is a collection of rows and columns.

CONTENT FOCUS

Machine learning models have specific applications based on the desired outcome of a given data set. Classification models sort a data set into groups of similar data (e.g., grouping students by interest in specific sports) vs. prediction models which create a prediction based on previous data to take a new data set and predict where it will go or do (ex. predicting a student's lunch order based on their previous orders.)

Strand	Artificial Intelligence
Topic	**Machine Learning**
	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	Artificial Intelligence
Topic	**Natural Interactions**

AI.NI.8.b Critically analyze and discuss features that make an entity "intelligent", including discussing differences between human, animal, and machine intelligence to identify how machine intelligence varies from natural intelligence.

Expectations for Learning

LEARNING PROGRESSION

In grade 7, students identified the components of a chatbot and explain how each component contributes to the chatbot's human-like responses. In high school, students will describe how artificial intelligence drives many software and physical systems.

IMPORTANT CONCEPTS

- Compare human, animal and machine intelligence.
- Explain what it means for something to be intelligent.
- List the ways to determine intelligence.
- Discuss ways to improve the intelligence of machine learning/Artificial Intelligence (AI).

KEY SKILLS/PROCEDURES

- Students will be able to analyze natural vs. machine intelligence and explain the differences and commonalities between the two.
- Students will be able to identify and describe elements of intelligence in humans, animals and machines to better understand how machines learn.

Content Elaborations

CLARIFICATIONS

Natural intelligence is the ability of a living being to think, gain from various expressions, comprehend complex ideas, solve numerical issues, adapt to new situations, use knowledge to manipulate one's environment and speak with fellow living beings.

CONTENT FOCUS

Machine intelligence is limited to the information given to it. It cannot learn and grow from mistakes or the past. It takes longer to adjust to new information than natural intelligence. Machines are faster than human brains. They are not able to mimic social and emotional behaviors on their own.

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	Artificial Intelligence
Topic	**Perception**

AI.P.8.a Explain how sounds and images are represented digitally in a computer to explain how sensor data is stored in a computer.

Expectations for Learning

LEARNING PROGRESSION

In grade 7, students explain how images are represented digitally by computer. In grade 8, students explain how sounds and images are represented digitally in a computer. In high school, students explain how radar, lidar, GPS and accelerometer data are represented.

IMPORTANT CONCEPTS

- Computers perceive the world using sensors.
- Perception is the extraction of meaning from sensory information using knowledge.
- Sounds and images can be represented digitally.

KEY SKILLS/PROCEDURES

- Explain how sounds are represented digitally in a computer.
- Explain how images are represented digitally in a computer.
- Understand how sensor data is stored in a computer.

Content Elaborations

CLARIFICATIONS

Sounds are digitally encoded by sampling the waveform at discrete points (typically several thousand samples per second), yielding a series of numbers.

CONTENT FOCUS

The transformation from signal to meaning takes place in stages, with increasingly abstract features and higher-level knowledge applied at each stage.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

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

Strand	Artificial Intelligence
Topic	**Perception**

AI.P.8.b Describe how a vision system might exhibit cultural bias if it lacked knowledge of objects not found in the culture of the people who created it to create inclusive and equitable data sets.

Expectations for Learning

LEARNING PROGRESSION

In Grade 7, students learned how edge detectors can be composed to form more complex feature detectors. In high school, students will learn what Artificial Intelligence (AI) can do that humans and more traditional programs cannot.

IMPORTANT CONCEPTS

- Define cultural bias.
- Discuss cultural bias as it applies to vision systems.
- Distinguish ways to overcome cultural bias in vision systems.
- Analyze how to make a vision set more inclusive and equitable.

KEY SKILLS/PROCEDURES

- Students will be able to analyze vision systems to understand how the data set for the system might exhibit cultural bias.
- Students will be able to explain ideas for creating more equitable and inclusive vision programs and why they are important.

Content Elaborations

CLARIFICATIONS

Cultural bias is the interpretation of situations, actions or data based on the standards of one's own culture. A vision system allows a computing device to inspect, evaluate and identify still or moving images. Domain knowledge must take multiple cultures into account if an AI application is to serve diverse groups.

CONTENT FOCUS

How does cultural bias impact the accuracy of vision systems? A self-driving car that only knows about American traffic signs will not be able to recognize traffic signs in Europe or Asia.

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	Artificial Intelligence
Topic	**Perception**

AI.P.8.c Illustrate how sequences of words can be recognized as phrases, even if some of the words are unclear, by looking at how the words fit together to create a text recognition program.

Expectations for Learning

LEARNING PROGRESSION

In grade 7, students learned how to illustrate the concept of feature extraction from images by simulating an edge detector. In high school, students will learn what Artificial Intelligence (AI) can do that humans and traditional programs cannot.

IMPORTANT CONCEPTS

- Recognize how the meaning of a word can change when it is used in a sentence.
- Explain how the meaning of a word can be determined by its context.
- Draw conclusions about how text recognition programs misinterpret an input because of the words it is given.

KEY SKILLS/PROCEDURES

- Students will be able to identify how words fit together into phrases and the impact of the phrase on the meaning of the words within it.
- Students will be able to create a series of phrases to work accurately within a text recognition program.

Content Elaborations

CLARIFICATIONS

Text recognition programs are also known as optical character recognition (OCR) and are used to detect text in images and scanned documents.

CONTENT FOCUS

Student should be aware of how the meaning of a word changes when used in a phrase and how that will impact text recognition.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

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

Strand	Artificial Intelligence
Topic	**Representation & Reasoning**

AI.RR.8.a Model the process of solving a graph-search problem using breadth-first search to draw a search tree.

Expectations for Learning

LEARNING PROGRESSION

In grade 7, students compared several algorithms that could be used to solve a specific type of reasoning problem. In high school, students will assess the impact of data on algorithmic outcomes.

IMPORTANT CONCEPTS

- Explain what a breadth-first search is and summarize when it is used.
- Relate how a breadth-first search is visualized in a search tree.

KEY SKILLS/PROCEDURES

- Students will be able to explain set theory and graph theory, specifically how information can be organized into a set, node and an edge (e.g., set: internet, node: computers, edge: routers).
- Students will be able to create a search tree that can be searched using breadth-search first.

Content Elaborations

CLARIFICATIONS

In computer science, a graph is a non-linear data structure that consists of nodes and edges, visualizes relationships between objects; it is a breadth-first search. An algorithm or method of graph traversal that considers a given node as the parent and connected nodes as children. A breadth-first search visits the sibling vertices before the child vertices.

CONTENT FOCUS

Graph theory shows the relationship between objects and set theory consists of sets of well-defined objects. Breadth search first allows a search of each node of a graph by moving through "children" of a node to "siblings" before moving on to the next "child" and repeating until the whole graph is searched.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

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

Strand	Artificial Intelligence
Topic	Representation & Reasoning
	Career Connections **CAREER EXPLORATION** Using OhioMeansJobs K12, students take the Career Cluster Inventory and ask themselves "Am I interested in a career in Computer Science?" Students use the Dynamic Career Pathways tool to explore occupations in this industry while using the Employment Projections tool to research further and determine whether a career in Computer Science may be of interest to them.

Strand	Artificial Intelligence
Topic	Machine Learning

AI.ML.8.a Explain the difference between training and using a reasoning model to identify how a machine learns.

AI.ML.8.b Illustrate how objects in an image can be segmented and labeled to construct a training set for object recognition.

AI.ML.8.c Explain how the choice of training data shapes the behavior of the classifier to identify how bias can be introduced if the training set is not properly balanced.

Expectations for Learning

In grade 7, students modeled how unsupervised learning finds patterns in unlabeled data to identify how machine learning takes place. In high school, students will explain at least one way that bias can enter the machine learning system and explain how that bias impacts people.

IMPORTANT CONCEPTS

- Describe training in machine learning.
- Describe using a reason model in machine learning.
- Compare and contrast machine learning using a training versus a reasoning model.
- Select the proper model (training or reasoning model) for machine learning.
- Construct training sets for object recognition.
- Balance the training set so that bias is not introduced.

KEY SKILLS/PROCEDURES

- Students will be able to define a training model in terms of machine learning.
- Students will be able to define a reasoning model.
- Students will be able to explain the difference between training and using a reasoning model.
- Students will be able to label data.
- Students will be able to identify bias in training data.

Content Elaborations

CLARIFICATIONS

Training is the process of providing a machine learning algorithm with data to learn from to create a machine learning model. A reasoning model, also known as machine reasoning, generates conclusions from available knowledge by using logical techniques like deduction and induction.

Students can be given a set of images and asked to draw a bounding box around every person, dog or traffic sign in the image, and label the object appropriately. As a follow-up, students could be asked to estimate the time it would take to construct a labeled data set with several thousand examples. Machine learning requires large amounts of data to be effective. Human expertise is usually required to label the data, which could be labor-intensive.

A classifier trained on a loan application data set where most of the rejected applicants lived in Pleasantville might decide to never make a loan to anyone who lives in Pleasantville.

CONTENT FOCUS

Students should be given a set of images and label the objects appropriately.

Strand	Artificial Intelligence
Topic	**Machine Learning**
	Students should know the differences and specific uses of training models versus a reasoning model. Bias can result if the model is asked to classify inputs that don't resemble the training data or if the training data contains irrelevant correlations the classifier should not rely on **COMPUTER SCIENCE PRACTICES** Practice 4. Developing and Using Abstractions Abstractions are formed by identifying patterns and extracting common features from specific examples to create generalizations. Using generalized solutions and parts of solutions designed for broad reuse simplifies the development process by managing complexity. By the end of Grade 12, students should be able to: 1. Extract common features from a set of interrelated processes or complex phenomena. 2. Evaluate existing technological functionalities and incorporate them into new designs. 3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity. 4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.

Strand	Artificial Intelligence
Topic	**Societal Impacts**

AI.SI.8.a Identify and explain how the composition of training data affects the outcome of a supervised artificial intelligence system to identify bias in data sets.

Expectations for Learning

LEARNING PROGRESSION

In grade 7, students identified and explained the effect training data has on the accuracy of an artificial intelligence system to uncover bias in training data. In high schools, students will identify, research and analyze current events in the field of artificial intelligence, considering new technology developments, social and ethical impact and future implications.

IMPORTANT CONCEPTS

- Analyze how the composition of training data affects the outcome of a supervised Artificial Intelligence (AI) system.
- Determine how bias can be identified in a training data set.

KEY SKILLS/PROCEDURES

- Students will be able to identify how the composition of training data affects the outcome of a supervised AI system and explain how this can be used to identify bias in data sets.

Content Elaborations

CLARIFICATIONS

Bias (in machine learning) is a phenomenon that skews the result of an algorithm in favor or against an idea. A supervised artificial intelligence system is a computer algorithm trained on input data that has been labeled for a particular output.

CONTENT FOCUS

Supervised AI is trained on a set of data that will give the desired result when run. Data sets with bias will cause the AI system to be biased, as the training data impacts how it responds to data sets given to it in the future. There are strategies for overcoming bias in data sets.

COMPUTER SCIENCE PRACTICES

Practice 3. Recognizing and Defining Computational Problems

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

Strand	Artificial Intelligence
Topic	**Societal Impacts**

AI.SI.8.b Identify bias potential in the design of artificial intelligence systems and describe how to utilize inclusive AI design to prevent algorithmic bias.

Expectations for Learning

LEARNING PROGRESSION

In grade 7, students identified and explained the problems of classification in the supervised artificial intelligence context to create data sets that are inclusive and accurate. In high school, students will analyze the impact new artificial intelligence developments have or will have on its intended users and society at large.

IMPORTANT CONCEPTS

- Explain the process of identifying bias in the design of an Artificial Intelligence (AI) system.
- Describe what strategies are used to prevent bias from occurring in an AI system.
- Explain how to use inclusive AI design to prevent algorithmic bias.
- Define an inclusive AI design.

KEY SKILLS/PROCEDURES

- Students will be able to define and explain inclusive AI design.
- Students will be able to identify bias in the design of an AI system.

Content Elaborations

CLARIFICATIONS

Inclusive design is a methodology that understands the full range of human diversity as a resource for a better design.

CONTENT FOCUS

Strategies for inclusive AI design include user studies, algorithm development and system validation.

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	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 workforce.
- Identify how technology contributes to automation/job loss.
- Technology can result in the need for refitting the educational requirements for jobs.
- Technology improves communication and collaboration in the workforce.
- 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 of 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.

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 include third world countries, equity, socio-economic status, and persons with disabilities.

KEY SKILL/PROCEDURES

- Explain that access is important for everyone regardless of their socioeconomic 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 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 accessibility. Students also need to identify the technology bias and accessibility issues that many people have globally.

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.

Strand	Impacts of Computing
Topic	**Culture**
	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 to 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 industries 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 the 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 applies 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.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

1. Include the unique perspectives of others and reflect on one's 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 the proper use of electronic devices whenever there was a lesson that involved the 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. Students 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 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 can 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 personal information (e.g., address, phone number, birth date, social security number, financial information).
- Be familiar with some of the "attacks" made by third parties trying to misuse the 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 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 personal (e.g., address, phone number, birth date, 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 those 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 can 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 must protect data.

COMPUTER SCIENCE PRACTICES

Practice 1. Fostering an Inclusive Computing Culture

1. Include the unique perspectives of others and reflect on one's 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 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 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 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.